NOTICES

FROM

FINSENS MEDICAL LIGHTING INSTITUTE

BY

NIELS R. FINSEN

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FROM

THE FINSEN MEDICAL LIGHT INSTITUTE

BY

NIELS R. FINSEN

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MEDDELELSER

FRA FINSENS MEDICAL INSTITUTE

IV

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ON THE USE IN MEDICINE OF CONCENTRATED CHEMICAL LIGHT BEAMS.

CONTINUED MESSAGES

OF

NIELS R. FINSEN.

Since I published my treatise in December 1896: "On the Use in Medicine of Concentrated Chemical Light Rays", which was accompanied by a "Preliminary Notice on the Use of the Method in Lupus Vulgaris", conditions have changed quite considerably. While I had then used the method for only one year and in only 11 cases of Lupus Vulgaris, it has now been used for 6 years and in over 800 cases of Lupus Vulgaris, in addition to many cases of other disorders. What was then an interesting experiment that promised much has now proven to be more than that, and the method has not only kept what it promised, but has also in several directions far exceeded my expectations.

The first and most important of the investigations which form the basis of the method and on which it is built have been published in the above-mentioned treatise; but my later investigations, which have had the purpose of improving and deepening the method, I have not yet published.

In the various, quite numerous reports on this treatment method that have been published in the past from the

The institute (see the list in "Reports from the Finsen Medical Light Institute" I. P. 4) has mainly concerned the results of the treatment, to which have also been attached reports on the most important changes and improvements that the treatment devices have undergone. On the other hand, almost nothing has been reported about why these changes were made. It is these underlying investigations that I will report here. I will also give a comprehensive description of the method and the position it currently holds in both technical and therapeutic terms.

These investigations, which for the most part now date back 4-5 years [1]), are essentially of a physical nature; they are quite naturally characterized by the fact that they were undertaken exclusively with special and practical purposes in mind, and by being carried out by a non-physicist. Despite the shortcomings resulting from this, I will nevertheless publish them, since there is a certain need for it. The method and my apparatus are already being used in numerous places abroad, and I therefore owe information about why the apparatus and method are exactly as they are, why, for example, one should use lenses made of glass for sunlight and of quartz for electric light, why one should use clear distilled water for electric light-collecting apparatus and bluish-colored water for solar-collecting apparatus. These and several other conditions seem to be in conflict with each other and need further explanation. If I do not provide the explanation and the underlying experiments, I may risk that the apparatus and technique will be changed in the wrong direction, to the detriment of the method.

First, however, I must make the observation that one might

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1) In carrying out these studies, I have had a lot of help and support from my two assistants at the time, Doctors Valdemar Bie and Axel Reyn, to whom I hereby extend my best thanks.

will consider some of my investigations to be superfluous, because the conditions are considered to be already known. To this I can only reply that when it turned out that various physical indications which I had found on my subject (concerning the absorption of rays, etc.) did not fit with my experiences, and when the light intensity which was involved in my experiments so far exceeded the light intensities generally used in experiments, I thought it best to take up almost all questions pertaining to this for renewed investigation.

The nature of these investigations naturally follows from the principles underlying the method, and these are, as is well known, an application of 1) the bactericidal and 2) the inflammatory properties of light, as well as 3) its ability to penetrate human tissues.

In order to be used in practice with any effect, however, the light must be strongly concentrated, and at the same time, in order to prevent combustion, the strong heat caused by the concentrated light must be removed.

The questions that therefore needed answering were the following: 1) Which rays in the spectrum are the most bactericidal. 2) To which rays is the inflammatory effect due. 3) How can one get rid of the annoying heat rays most easily and best, without at the same time losing the beneficial bactericidal and inflammatory rays? 4) What is the situation with the passage of light through the tissues? Furthermore, other questions arose that also concerned light, and which were partly dependent on the answer to the preceding ones, namely: 1) What can be done to obtain artificial light that is rich in rays with the desired properties and poor in heat rays? 2) Which parts of the electric arc light are the best, the light that emanates from the coals, or the light that emanates from the arc? 3) How does sunlight differ from electric light, and what 1*

Does this difference have significance for the construction of solar devices and for the treatment of diseases?

This is followed by another series of studies on the best way to concentrate the light, so that one gets as much as possible out of the good properties and avoids as much as possible the disadvantage of the heat rays.

I will, as far as possible, address each question individually and either provide an answer to them or point you to where you can find answers.

1. Which rays in the spectrum are the most germ-killing?

To this I could already reply in my above-mentioned first treatise, p. 13, that according to numerous investigations which I also found confirmed by my own experiments, the most refractible, the blue-violet rays, must be considered the most strongly bactericidal, while there was some divergence concerning the most refractible, the ultraviolet. By more extensive investigations which were later carried out at the Light Institute by Dr. V. BIE [1]) on this extremely important point, and to which I refer, much more clarity has become available as to what an exceptionally large part of the bactericidal power of light belongs to the most refractible rays, and what an insignificantly small part the less refractible rays (the red and yellow) possess. Dr. BIE'S investigations were carried out with collecting apparatuses, provided with glass lenses, and his results are of the greatest importance for all rays which could pass through glass; but a large part of the ultraviolet rays are absorbed by glass, as is well known,

while they pass through rock crystal. It was now of great importance for the method to know how much significance these ultraviolet rays absorbed by — glass had as germicidal agents; — on this would depend whether rock crystal lenses should possibly be used for the light-collecting apparatus instead of glass lenses as hitherto.

I therefore conducted (May 22, 1897 at 101 pm) experiments in this direction, which I refer to in my Experiment Book.

The light from an 80 Amp. lamp was collected by means of a small collecting apparatus, consisting of a metal tube 6 cm. long, one end of which was closed with a rock crystal plate 6 cm. in diameter, and the other end of which was closed with a rock crystal lens 51/2 cm. in diameter and 6 cm. in focal length, between which was distilled water. By means of this apparatus the light was collected on a spot 6 mm. in diameter on a plate culture of Prodigiosus, in the same way as we are accustomed to use them at the Light Institute, only in this experiment I let the light fall directly on the culture, that is, on the surface facing away from the glass. I made 3 experiments, each lasting 5 minutes. In the first experiment a rock crystal plate was placed between the collecting apparatus and the culture, in the second experiment a glass plate of ordinary window glass, in the third experiment a somewhat thicker plate of clear mirror glass. On inspection the next day at 11/2, a weakening of the growth of the culture was seen on all 3 spots. On the two spots where the light had passed through the glass plates, the growth was weakened approximately equally, but very slightly; on the other hand, much stronger where the light had passed through the rock crystal plate (the three spots were placed side by side on the same plate culture). On inspection the following day (the 24th) at 31/2, the rock crystal spot was seen clearly and distinctly, here the majority of the bacteria had been killed, only a very few colonies had grown. On the two glass spots, however, the growth was now just as good as on the unlit parts, pigmented everywhere, only a little darker in color than on the

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1) V. BIE: Studies on the Effect of the Different Parts of the Spectrum on the Development of Bacteria. "Reports from Finsen's Medical Light-Institute I. P. 33.

the unilluminated part. This result, which I have found confirmed by later similar experiments, shows an extraordinary preponderance of bactericidal power in the extreme ultraviolet rays. A necessary consequence of this experiment was the introduction of rock crystal lenses instead of glass for the treatment apparatus, and as can be understood, an extraordinary amount has been gained by this. I cannot, however, state exactly how much has been gained by this change in figures, but you will get an impression of it when I mention a few figures. Dr. BIE found in his investigations that concentrated light from a 35 ampere lamp, concentrated by a glass collecting apparatus, killed a Prodigiosus culture after 35 minutes of exposure. With a rock crystal collecting apparatus (with 7 cm. lenses) and a lamp of the same size I have been able to kill a culture of the same bacteria in 2-3 seconds [1]).

To investigate how the situation was with sunlight, I later carried out some experiments that were arranged according to the same principle as the last-mentioned experiment with electric light; for this I used a collecting apparatus with a rock crystal lens of 10 cm.s diameter. The result was quite different here, as there appeared to be very little difference in the effect, whether the light had passed through rock crystal or through a thick mirror glass plate. Sunlight that had only passed through rock crystal had the same effect on Prodigiosus for 4 minutes as light that had passed through the glass plate had for 5 minutes.

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1) These figures could not be considered as an absolute measure of the difference in the performance of the devices, since there are so many sources of error with regard to the cultures that these experiments have not taken into account (see S. BANG'S thesis: On the effects of light on microbes, Communications from Finsens's Institute of Light II. p. 1); but they do give an approximately correct idea of the great difference between the two types of devices.

This gives a fairly good practical impression of how great a difference there is between sunlight and the strong electric arc light with regard to the content of the outermost ultraviolet rays retained by glass. Sunlight has relatively few of these rays, based on the fact that the atmosphere absorbs them to a high degree. It follows, for example, that sunlight on high mountains is much richer in these rays than in the lowlands (see ABSALON LARSEN'S Aff.: Om Sollysets Intensitet. Meddelelser fra Finsens medicinske Lysinstitut I. P. 109). In the strong electric arc light, on the other hand, the vast majority of the bactericidal effect is due to these ultraviolet rays.

Theoretically, according to these experiments, one should use collecting devices with rock crystal lenses for both sunlight and electric light, since such devices would give absolutely better and more powerful light. But in practice the situation is different.

I will first mention how the situation is with sunlight. Since the rays here are parallel, the strength of the light, all other things being equal, will depend on the size of the area of the lens. This relationship is very favorable for those concerned with glass, since one can easily get glass lenses as large as one needs; but unfavorable for those concerned with rock crystal, since there are very narrow limits to the size of lenses of this type of rock. The largest rock crystal lens that I have seen and have been able to get is 11.5 cm. in diameter, but such are very rare and very expensive; on the other hand, one can fairly easily obtain rock crystal lenses of 7-8 cm. in diameter, although they are of course also expensive [1]).

From my experiments with bacteria described above, it became clear that one can approximately state the relationship between a rock crystal lens and a glass lens of the same diameter, same

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1) While rock crystal lenses of 10-11 cm.s diameter cost 150-200 DKK., those of 7-8 cm.s diameter cost c. 30 DKK. Each.

Focal length and the same thickness, as 5 to 4, when it comes to utilizing the germicidal power of sunlight; in other words, only a very small increase in diameter is needed for a glass lens to be equivalent to a rock crystal lens. As an example, I would mention that a glass lens of 11 cm. in diameter would be equivalent to a rock crystal lens of 10 cm. But when one further considers how disproportionately the area increases in relation to the diameter, so that, for example, a lens of 20 cm. in diameter has an area 4 times as large as a lens of 10 cm., one will understand how disadvantageous it would be to use rock crystal lenses for sunlight.

It is different with electric light. First, the useful effect of rock crystal, as I have shown, is here so exceedingly much greater than that of glass, and secondly, the size of the area of the lens plays a much smaller role here, because the rays are divergent. When a lens with a small area is placed close to the light, it can, as is well known, receive an equally large or even larger amount of light than a lens with a much larger area, which is placed at a somewhat greater distance from the light. Of course, the size of the lenses is not absolutely unimportant, since there are certain practical disadvantages in their being too close to the glowing coal tips (they easily break, and are quickly dusted by the coal particles constantly falling down during the combustion of the coal). At a fairly large distance from the arc (12-15 cm.), these disadvantages are not very great, and in any case minor in comparison with all the advantages of using rock crystal. Even the high price of these lenses is of secondary importance when one considers think of the enormous difference that exists between glass and rock crystal in relation to this light[1]).

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[1]) This transition to the use of rock crystal lenses for electric light was, however, in reality a return, as I had already in Vienna

2. To which rays is the inflammatory effect linked?

I can limit myself to answering this question here in the shortest possible time, referring to my dissertation: "New Studies on the Effect of Light on the Skin" (Reports from the Finsen Medical Light Institute, I. S. 6), where I have made this question the subject of detailed research. The answer is that it is exactly the same rays that are effective in affecting bacteria, and that there is the same or approximately the same difference in the effect on the skin as on bacteria of electric light that has passed through glass and that which has passed through rock — crystal. [1]) Consequently, everything I have said in the previous section also applies to this section: In order to obtain the strongest possible effect of the light, it is most expedient to use rock crystal lenses for electric light and glass lenses for sunlight.

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the year 1895-96 had used a rock crystal collecting apparatus for the treatment of lupus. The development was as follows: I began (in November 1895) with a glass lens, but quickly became aware that rock crystal was preferable from a — from theoretical point of view. I therefore obtained the same winter lenses of rock crystal. But when it turned out that they were so extremely expensive and could only be obtained in very small diameters, I went back to glass lenses. This return to glass was probably quite right at that time, because at that time I only had a weak arc lamp with relatively few ultra-violet rays at my disposal, and at that time I had not yet found the use of the double system of lenses (with parallel rays in between), which changed the situation completely and, so to speak, nullified the advantage of lenses with large diameters.

[1]) Whether these are exactly the same rays, one cannot of course say with absolute certainty, but as far as one can judge from the methods of investigation currently available, they are the same.

3. How can one get rid of the annoying heat rays most easily and best, without losing the beneficial bactericidal and inflammation-causing rays?

Completely getting rid of the heat of the light is a physical impossibility, since all rays of light possess the property of heating, only they have it to varying degrees. Therefore, in the question posed, I have only spoken of the "annoying" heat, and what I understand by this expression I can state quite definitely in numbers. By numerous measurements of the heat at the point of the light cone that the patients could tolerate without feeling pain, I have found that 45°-55° C. can be set as an average for what can be tolerated.

It was now a question of constructing apparatuses which could give a light cone with the strongest possible chemical luminous power without exceeding this temperature at the focal point. The work on this has been partly of a common nature and partly different for electric light and solar light, so that I must partly treat each separately.

I need hardly remark that hand in hand with these various investigations and, as a result of them, there have been constant constructions and new constructions of collecting apparatus, so that there are several links between the apparatuses which we now use and those which are mentioned in my above-mentioned book from 1896. It is not worth dwelling on most of these transitional forms; in the following I will only mention the most important ones.

Common to both kinds of light have been the investigations into the absorption of heat rays and chemical rays by water and various solutions. I had already carried out a number of investigations in this direction, and I mentioned them in my

Thesis from 1896, but the most important studies were carried out later.

The questions that it proved necessary to answer were, in the case of clear, colorless water, the following: What is the relationship with the absorption of water, a) of heat rays and b) of chemical rays, respectively. c) What is the significance of the thickness of the water layer, and d) What is the significance of the temperature of the water. This was followed by e) Studies on the light absorption ratios of different solutions in order to find the solution that was best suited to the collecting apparatus, that is, the solution that absorbed the most heat rays and the fewest chemical rays.

a). Water's Absorption of Heat Rays.

For these and the following experiments on absorption I used the light from a 35 Amp. arc lamp, concentrated by means of one of my electric light-collecting apparatuses of the type described in 1. c. p. 25. To determine the temperature I used a cattle silver thermometer, the ball of which was blackened with carbon black. The thermometer was kept in all the experiments at the same place in the cone of light, at the very focal point.

First I measured the temperature without filling the apparatus with water, it showed 325° C. (Average of 3 measurements 290°, 360° and 324°), then I poured water into the container of the apparatus, and now the thermometer showed 111°. (Average of 6 measurements, varying from 89°-123°). The thickness of the water layer through which the light had passed was 13 cm.

The rather large variation in the temperature, which was taken at fairly large intervals, is due to the lamp, whose light is rarely quite the same in the same place for a long time, for even if the current and voltage are kept quite unchanged, e.g.

The shape of the crater produces a large difference in brightness. For my purposes, however, these results were fine enough.

It is seen that the water layer has lowered the temperature of the light by over 200°. Since it is now known that water absorbs only a very small amount of the visible rays of light, this loss of heat must therefore be mainly due to an absorption of the invisible, ultra-red rays of light.

In order to find out whether all the ultra-red rays or approximately how many were absorbed by the water layer, I placed a light filter of 1 cm.s thickness, filled with an opaque solution of iodine in carbon disulfide between the apparatus and the thermometer (which solution absorbs all light rays, but is passable for the ultra-red rays), it now showed 26° (room temperature 20°). It can be seen from this that the water layer has almost completely removed the ultra-red rays. When I placed the same filter in front as a control experiment and at the same time emptied the water container of the collecting apparatus, the temperature in the invisible focal point went up to 172°.

b). Water's Absorption of Chemical Rays.

Of all liquid media, water is the most, or one of the most, permeable to the chemical rays of light, and experiments can convince one that the loss of chemical effect of light by passing through a layer of water is in reality quite negligible. When it comes to glass apparatus, one can even demonstrate that water is beneficial; if one measures the chemical effect of the light cone after it has passed an empty glass light filter, and then measures the effect after the light filter has been filled with water, one will see that the effect in the latter case is strongest; this is explained by the fact that the reflection from the glass sides is less when there is water in the filter than when it is empty. I have carried out my experiments on this in the following way:

let the light cone act on silver chloride paper (Aristo paper). In all experiments the paper was placed in the same place of the light cone, and the experimental time was the same in all comparative experiments. By then comparing the color of the spots blackened by the light, I was able to form a rapid and for my purpose sufficiently reliable estimate of the absorption of the chemical rays. As I have already stated, my experiments confirmed the great, almost complete permeability of water to these rays [1]).

c). The importance of the thickness of the absorbent water layer.

In practical terms, it matters a lot whether the Sanile apparatus should be constructed with a thick layer of water, or whether a thin layer can be sufficient. For the apparatus for electric light, however, it matters relatively less, since these apparatus are fixed and supported by strong iron arms. For the solar apparatus, on the other hand, the question is of great importance. When the water layer is large, the apparatus becomes very heavy and unwieldy; as an example, I will mention the solar apparatus described in my above-mentioned book, p. 24; it has a water layer of 40 cm.s thickness and holds about 10 liters of water. Because of its weight, it was difficult to transport and cumbersome to use and is therefore no longer used.

I carried out the above experiments with the same lamp, the same apparatus and in the same way as described on p. 11, gradually placing light filters of different thicknesses, filled with

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1) As far as I remember, I have not noted anything about it in my experiment book. All my — experiments were carried out with distilled water, which we always use for the apparatus and light filters. There is, with regard to the absorption of the outermost ultraviolet rays, a considerable difference between ordinary water and distilled water (see ABSALON LARSEN'S thesis, Meddelelser II. p. 103).

Water, between the apparatus and the thermometer. Since I did not have filters of all thicknesses, I sometimes placed several filters next to each other, which does not correspond absolutely to a single filter of the same thickness[1]), but this, as is also evident — from the figures, does not play any — significant role in such rough experiments as mine.

The results of my experiments are found in the table below, in which I list the thickness of the water layer, the number of filters and the temperature.

Thickness of the water layer	Number of Filters	Tp. i Focus
0	0	325 ° C.
1 cm.	1	180 ° C.
2.5 —	1	126 ° C.
3.5 —	2	114 ° C.
13 —	no filter, but water in the device itself	111 ° C.
26 —	Water in the device + 1 Filter	107° C.

This table shows how important even a thin layer of water is, and how little benefit is gained by making the layer very thick. Consequently, a thick layer of water should not be used if this causes the disadvantage of making the apparatus too heavy and unwieldy, while it is expedient to leave the water layer thick where these considerations do not need to be taken into account. In the case of solar apparatuses, which have a large diameter and must be moved frequently, this, as stated above, plays a major role; therefore, in the latest designs of these apparatuses, I use a water layer of only 4-5

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[1] The more glass surfaces the light has to pass through, the greater the loss of light through reflection.

cm.s Thickness. In the case of the apparatus for electric light the relationship is reversed, the lenses have a small diameter and the apparatus is fixed, therefore one can use a thick layer of water here without any disadvantage; I therefore use a water layer of 35 cm in the newest forms.

d). The importance of the absorbing water layer temperature.

At first glance it might seem quite natural to assume that the temperature of the water layer must have some significance when it came to absorbing heat rays, so that cold water absorbed better than hot. This seems to be a common opinion, since almost all medical investigators who have worked with light without heat have emphasized that the light passed through a layer of water that was always kept cold. A decision on this question was all the more necessary for me, as the water in the light-collecting apparatus after a few hours of use becomes very hot, can almost reach the boiling point, and cooling the water, by constantly pouring cold water through it or in some other way, was a very laborious thing, which I would only take action on if it was very necessary.

My experiments on this were carried out with the same lamp, the same apparatus and in general in the same way as in the above-mentioned investigation. There was no water in the apparatus itself, but a light filter 1 cm thick was placed between the apparatus and the thermometer. This light filter was gradually filled with water at 5°, 45° and 73°, the corresponding temperatures, measured at the focal point, can be seen from the table below. I do not remember how many experiments I made of each kind, in my book it is only noted:

Filter of 1 cm.	Water 5°	174°
— — —	— 45°	— 198°
— — —	— 73°	— 180°

After these measurements, the variations of which could be considered to fall within the normal limits of error (see p. 11), I had in each case seen so much that there was no considerable difference in the absorptive capacity of the water, whether it was cold or hot, and I therefore considered it quite unnecessary to take the rather laborious measures of cooling the water in the collecting apparatus. When, however, I later (see p. 34) have come to the subject of cooling the water in the apparatus, it is for a different reason.

Before I conclude my discussion of water, I would like to point out that freshly distilled water must absolutely be used for both solar and electrical devices; apart from possible absorption conditions (see — ABSALON LARSEN'S above-cited article, p. 103), there are two practical considerations which make it unwise to use ordinary water. Firstly, as the water is heated, numerous air bubbles gradually settle on the lenses, thereby losing an extraordinary amount of brightness; secondly, ordinary water gradually deposits lime salts and other impurities on the lenses. We have also tried to use boiled water, but so far we have not been able to get it sufficiently clear.

e). Studies on the Absorption of Heat Rays and Chemical Rays by Various Solutions.

As mentioned in my above-mentioned thesis, pp. 20-21, I initially used a solution of methylene blue for my collecting devices, both for electric light and for sunlight, in order to remove even more of the heat rays of the light than water alone.

is capable of. In order to find out which solution performed best in absorbing heat rays and at the same time allowing the chemical rays to pass, I made a series of investigations.

First I examined spectroscopically all the clear soluble blue colours which it was possible for me to obtain; in doing so I found that methylene blue, alkali blue and an ammoniacal solution of sulphuric acid cupric oxide best met our requirements. The two first-mentioned showed by spectroscopic examination almost exactly the same absorption spectrum, however the spectrum of methylene blue was apparently the most favourable, and with this substance and the ammoniacal solution of sulphuric acid cupric oxide I therefore made a series of comparative experiments in order to determine directly, by means of a thermometer and photographic paper, their ability respectively to retain heat rays and to let chemical rays pass.

Since these are the same dyes that I mentioned in my above-quoted thesis, and since these later, more thorough investigations have shown that the assumption that I made at that time was not correct, I will state what I said about this situation in order to have it corrected at the same time. It is mentioned in 1. c. P. 20 in the following way: "since the ammoniacal solution of sulfuric acid copper oxide quickly discolors on contact with the metal sides of the apparatus and is otherwise less pleasant to use, I have now switched to a solution of methylene blue. The sulfuric acid copper solution, when sufficiently strong, certainly completely excludes the red rays, but a strong methylene blue solution does not. On the other hand, by a spectroscopic examination of a weak solution of the two colors, apparently of equal color strength, one will see that the methylene blue solution absorbs more red rays than the copper vitriol solution; and since one now generally only needs a partial exclusion of —

the red rays, the methylene blue solution is also preferable for this reason."

The experiments I will mention here were carried out with the same lamp and the same collecting apparatus as the above-mentioned experiments on the absorption of water, and with the same light filter of 1 cm.s thickness. The temperatures mentioned here could therefore be easily compared with the temperature (180°) mentioned above for a layer of water of 1 cm.s thickness; by such a comparison one obtains a numerical indication of the significance of filtering the light through blue-coloured water.

For the experiments I prepared two deep blue, apparently equally colored solutions of methylene blue and sulfuric acid copper oxide with ammonia. Then the light filters with these solutions were alternately placed in front of the light cone, after which the temperature was measured in Focus.

The result of the experiments was that I found an average of 61° for the copper solution, and 116° for methylene blue (for clear water the temperature was, as mentioned, 180° under the same conditions). By now testing the effect on photographic silver chloride paper, it was also shown that the same copper solution allowed more chemical rays to pass through than the methylene blue solution.

Then water was poured into the collecting apparatus (a water layer of 13 cm.). As a result, the Tp. as mentioned above was 111°; when the copper filter was now placed in front, the Tp. in Focus went down to 34°, when the methylene blue filter was placed in front, to 57°.

The solutions used here were, as mentioned, rather dark; in experiments with a weaker solution (the same solution half diluted with water) and with water in the collecting apparatus, the Tp. in Focus for the copper solution was 45° and for the methylene blue solution 58°1). From this last experiment it was found that

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1) Since it may be surprising that this number is approximately the same as that found with the stronger methylene blue solution, I will state the result of

There is certainly some truth in what I said at the time about the difference between a weak and a strong methylene blue solution, compared with a copper solution. The main result, however, is that, both from the point of view of heat dissipation and from the point of view of the poor absorption of chemical rays, the ammoniacal solution of sulphuric acid copper oxide should absolutely be preferred.

Comparative experiments, arranged in exactly the same way as these last-mentioned, I have also made between an ammoniacal copper sulphate solution and various solutions which are stated to have a particularly great absorption capacity for heat rays, namely: solutions of alum, of sulphuric iron oxide, ferric chloride, etc.; but the result was that the copper solution proved to be far preferable to all of them. For these reasons we now always use copper solutions for the — collecting apparatus when more heat is to be absorbed than water alone is capable of. We try to reduce the disadvantages mentioned in the use of copper solutions (rapid decomposition, etc.) by coating the metal which comes into contact with the solution with asphalt varnish.

For the collectors of sunlight we still use copper solution, as it offers great advantages. For the collectors of electric light we also used it for a time, as long as we still used lenses of glass; but when the rock crystal lenses were introduced, the copper solution could no longer be used, as it absorbs the chemical rays to an even greater extent than glass in the liquid thicknesses of which we are here speaking.

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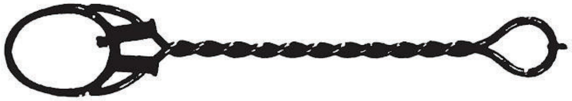
the individual measurements. Both figures were averages of 3 measurements; at the strong solution the temperatures were 57°, 54° and 61°, at the weak 69°, 48° and 56°.

4. Penetration of light into the tissues (Pressure glass).

In order to make the chemical rays penetrate as deeply into the tissues as possible, we always use pressure glasses, which press the blood away from the place to be treated, which, as I have shown 1. c. pp. 33-37, is of great importance. This is naturally of greatest importance where the treatment of deeply infiltrated parts is concerned. On the other hand, we have found that in quite superficial affections the goal can be achieved without pressure glasses; as an example I will mention a couple of cases of superficial lupus of the eye socket and upper eyelid, where it was not possible to use pressure glasses for the sake of the eye.



1/2 night. Size.

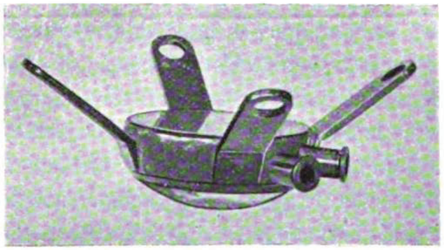
It goes without saying that the shape of these pressure glasses must vary somewhat according to the places where they are to be placed. In addition to the shapes previously mentioned, 1. c. p. 36, I would like to mention pressure glasses with a concave plate (for treating the eye socket) and a special shape, a small oval pressure glass with a stem (see Fig.) which we use in treating the corner of the eye and other places where it is difficult to place the usual 'pressure glasses.

Of greater importance is a change which I (1897) indicated in connection with the pressure jars, and which I will discuss in more detail, as it actually means in practical terms a very great improvement of the method. This change consists in using hollow, water-filled pressure jars, through which cold water is constantly flowing by means of an inlet and an outlet pipe.

In the constant striving to get rid of the troublesome heat of light, I had hitherto, as is evident from the foregoing, chiefly sought to achieve the goal by means of

of media which absorbed the heat rays. With regard to the importance of pressure glasses in this respect, I had only made the following experience: the sensation of heat was reduced when the glass was pressed strongly against the skin. But when one day I was making experiments on my arm with the light from a collecting apparatus, and the light burned strongly on the skin despite the fact that it had passed through a thick layer of water, we tried to sprinkle the skin with water; by this the sensation of heat completely disappeared. The same thing happened when a pressure glass was placed on the skin and this was sprinkled with water. By further experiments it was shown that even extremely hot spots of light, even such as immediately caused the most terrible pain on the arm, could be tolerated when the skin was covered with a pressure glass which was sprinkled with water.

Since constant irrigation would, however, present some practical difficulties in treating the patient, I tried to



2/3 nights. Size.

if one could not be content with hollow pressure glasses filled with cold water[1]), but experiments showed that although these provided much benefit, the advantages of the constant change of the water were so disproportionately great that I decided to introduce the mentioned hollow pressure glass with a trickle. By this change the pressure glass, or as they should rather be called, the pressure apparatus, have been given two tasks, namely to press the blood aside, and to have a cooling effect on the skin (by conduction). These two tasks are so important and essential and of such great practical importance that the third effect they exert, namely to absorb heat rays, can be left completely out of consideration from a practical point of view. If there were no water in the collecting apparatus, the importance of this would be great, since even a thin layer of water (see my table p. 14) is of extraordinary benefit. But since there is no disadvantage in placing a layer of water in the collecting apparatus itself, on the contrary a great advantage, since here one can make the water layer, in the one case (electric light) very thick, in the other case (sunlight) blue-coloured, this is of course to be preferred. From the aforementioned table, it can also be seen that the absorption of heat rays by pressure devices is practically meaningless, since almost all the heat rays that can be absorbed by water are already absorbed by the collecting devices themselves.

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[1]) While, as I have shown above, it is quite unimportant whether the water in the containers of the collecting apparatus is hot or cold, since the water's ability to absorb heat rays is roughly the same in both cases, the situation is quite different with the water in the pressure glasses, which is supposed to have a cooling effect by conduction; in this case, it naturally cools the skin more strongly the colder it is.

The great practical significance of the introduction of these pressure devices with water permeation for the method will perhaps be best illustrated by the following experiment. I placed on my arm a hollow pressure device, through which water at 12° C. flowed, and then exposed the arm to the light cone from a large solar collector (a water lens of about 30 cm. diameter with clear water). I now tried how close to the focal point I could bear to hold my arm without feeling any pain. The distance from the lens was then measured, and in the very same place a cattle silver thermometer was now placed, the ball of which was blackened with carbon black. The Tp. turned out to be 220-230° C.; a stick, which was held in the same place, that is, where my arm had been, immediately emitted large clouds of smoke and glowed. When one now considers that the

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The Tp. of the light cone, which one could generally tolerate with the pressure devices used up to now, was 45°-55° C., then one will understand how great the significance of this improvement in the pressure devices was, and how much stronger light we could use for treatment after their introduction. While previously we could not use lamps stronger than 35-50 Amp., we could now use them at 60-80 Amp.

The condition for the skin to be exposed to radiant heat without pain and without injury, which would otherwise char it, is of course that the cooling 2: The dissipation of the heat occurs more rapidly than the heating of the skin by absorption of the rays. A substance that conducts heat well is therefore preferable, and since rock crystal, like other precious stones, is a far better conductor of heat than glass, it is theoretically preferable to glass for printing apparatus. I would add that this difference in conductivity is large enough to have practical significance. When, as mentioned above (p. 6), we introduced rock crystal lenses for the collecting apparatus for electric light, we of course also introduced rock crystal into the printing apparatus; one can therefore see that there are two reasons for the use of rock crystal here; and one now understands the apparent inconsistency in the fact that for sun treatment we use glass collecting lenses, but rock crystal pressure devices.

Collectors for Sunlight.

The form of these has changed not so little in the intervening time as a consequence of the above-described investigations into the absorption of light. From the form of collecting apparatus which is described 1. c. p. 24 to the form which we use at the present time, and which has not undergone any essential changes during the last three years, there have been numerous transitional stages. Although it might seem unnecessary to mention

These transitional forms, I will however mention some of them, in order to have the opportunity to state why we have not been satisfied with these forms; this is the best way to avoid others going the other way in the belief that they are making improvements.

The solar apparatus, which is described 1. c. P. 24 but which was far from the first form, consisted of two massive glass lenses, one 30 cm. in diameter and the other 18 cm. in diameter; between them was a water layer 35 cm. thick. The apparatus held about 10 liters of water and was very heavy to transport and set up, and so difficult to move that we often preferred to move the patient when the movement of the sun made movement necessary. In the studies mentioned above (P. 14) on the significance of the thickness of the water layer, it turned out, however, that such a thick water layer was of relatively little use. I therefore constructed the next solar apparatuses with much thinner water layers, which made them much easier to handle.

As the large solid glass lenses were relatively expensive, I tried to get myself hollow glass lenses; but as I was not so lucky as to find a glassworks that could and would make them, I tried large watch glasses, which were putty into a metal ring; these lenses were considerably cheaper, but only became really useful when I had curved glasses made especially for this purpose. This was only possible after numerous unsuccessful attempts, as there are some technical difficulties in making them of large size and exactly spherical.

However, it soon became apparent that for reasons to which I will return later it was impractical to use the very large lenses (40 cm. in diameter). The size 20-30 cm. in diameter proved to be most suitable, and glass of this size was not so difficult to obtain, but only with a fairly strong curvature. The result of this was that Lindsen's fire-width became rather short (30-40 cm.), and that the collecting apparatus always had to be placed very close to the patient. When this proved to be no small disadvantage, I proceeded to make one side of the Lindsen plane by inserting mirror glass instead of the one curved glass; this made the focal length twice as long, and the use of the apparatus much more convenient. This is the simple reason why the Lindsen in the solar apparatus is always plano-convex, a condition which still raises many questions.

However, I have not yet succeeded in obtaining as good glasses as I could wish. Due to the method of manufacture, as far as I know, a large — sphere is first blown, from which the glasses are cut out as segments, they are never perfectly accurate and never collect the light as well as ground, solid lenses; the light spot at the focal point is most often irregular (angular, oval, etc.). When I thought that perhaps more was actually lost by this irregularity than was gained in the other direction, namely by the cheapness of the lenses (they were about 10 times as cheap as the others), I again switched to trying solid glass lenses, but in such a way that I only let one side of the apparatus consist of a lens (plano-convex, with the flat side facing the water), while the other consisted of a flat mirror glass plate.

This achieved the advantage that the light was collected beautifully, so that the light cone was regular and the spot round at the focal point. Next, there was the additional advantage that the blue-colored water layer was equally thick everywhere. When the Lindsen, on the other hand, is formed of a curved glass, the water layer is of course thickest in the middle, which is unfortunate, since the central rays (which must be assumed to be the most favorable, as they are collected best and refracted the least) will pass through the thickest water layer and thereby be absorbed more strongly than the peripheral rays, which pass through a considerably thinner water layer.

But when I then made comparative experiments with two devices of the same diameter and under exactly the same conditions, it turned out that the device with the curved glass, despite its poorer ability to collect light, killed bacteria more quickly than the device with the solid lens. This difference must therefore be due without a doubt to the greater absorption of ultraviolet rays by the thick glass. Here, therefore, the cheapest was also the best.

In order to remedy, if possible, the disadvantage that the blue layer of water, as mentioned, was thicker in the center than in the periphery, which was particularly important with the large apparatuses, and when the liquid in strong sunlight was to be relatively dark in color, I made a number of experiments.

I constructed some apparatuses, the lens of which was filled with clear water, while either in front or behind it was placed a light filter with flat walls, filled with the blue solution. In other apparatuses, plates of blue glass were placed instead of filters, so that in weak sunlight one could be satisfied with one plate, in stronger sunlight with two or more. The apparatuses with light filters, however, were abandoned because they became too heavy and unwieldy, the apparatuses with the blue glass plates because it proved impossible to obtain glass of a suitable color. In comparison with colored solutions (copper solutions), it turned out that the blue glass allowed more heat rays and fewer chemical rays to pass through than the blue solution. Next, I tried to coat the flat surface of the lens with transparent blue-colored gelatin, but this also did not prove practical. All these and several other methods of achieving uniform absorption of heat rays over the entire area of the lens later proved to be quite redundant, as I gradually became aware that there was no advantage in using very large lenses.

It was shown by experiments that when the liquid was

made very deep blue, — which was necessary for the large lenses, because they heated so strongly, it absorbed so many chemical rays that the advantage that one should have from the large area of the lens was actually lost, so that these large lenses often even gave less than lenses of considerably smaller area, filled with a brighter solution. Experience has therefore shown that for this reason, at least below our latitude, it is impractical to use lenses of larger diameter than c. 30cm.

One might ask here whether it would not be wiser to use the large lenses and thus make the treatment spot larger, thereby simultaneously treating a larger area. However, this could not be done because the light outside the focal point of the lens is collected far too unfavourably to be used. If one wants to use the light inside the focal point (between the lens and the focal point), one gets a disproportionately strong amount of light in the periphery of the spot and very little light in the center; if, on the other hand, one wants to use the light cone outside the focal point, one gets the exact opposite, namely too strong and warm light in the center and very weak in the periphery. These conditions can be easily and clearly convinced of by placing photographic silver chloride paper at different points of the light cone and examining the shape of the blackened figure[1]).

I must also add that I have tried, instead of using lenses, to collect the sunlight with a silver parabolic mirror; but I quickly gave it up when the collected light was

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1) I must note, however, that the task could be partly solved by making solar apparatuses with a lens of very weak curvature; such a lens would give a good focal point of a larger area; but, firstly, I have not yet succeeded in obtaining such weakly curved large glasses, and secondly, the very long focal length that such a lens would have to have would entail such frequent movement of the collecting apparatus that the advantage of such apparatuses would possibly be small or none in practice. Experiments should, however, be made with such lenses when they can be made.

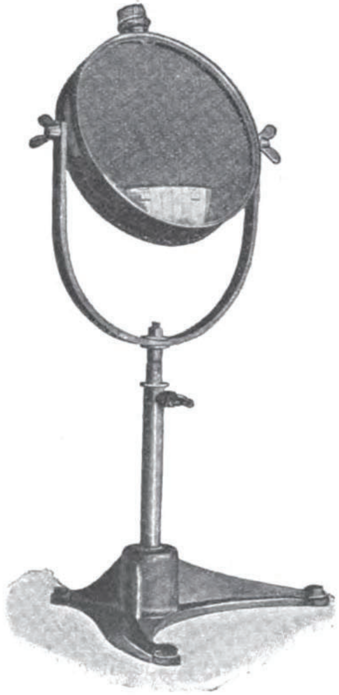
extremely hot and at the same time relatively poor in chemical rays. I have also mentioned above (p. 6) that I have made comparative experiments between solar apparatuses with glass lenses and with quartz lenses.

The result of these investigations and of the experiments with the above-mentioned and several other types of collecting devices is that for the time being I have settled on a solar device of the form which I will now describe, and which can be seen in the accompanying picture.

The apparatus consists of a tripod and a lens. The tripod, which is intended to be placed on a table, carries a fork at the top, which in turn carries the collecting lens. The latter can be rotated about a vertical as well as a horizontal axis and can be raised and lowered according to the sun's high or low position.

We have the collecting lenses of different diameters and different focal lengths; but the dimensions which I consider most favourable for Danish conditions are a diameter of c. 25 cm., a focal length of c. 70 cm. and a distance between the two glasses that form the lens of 4-5 cm. in the periphery. Whether one wants to use a biconvex or planoconvex lens can be of no importance, only one should ensure that the glasses are as thin as can be combined with a sufficient strength. These collecting lenses are filled with distilled water, which is colored blue with an ammoniacal solution of copper sulfate, which of course must always be quite clear and transparent. The strength of the solution cannot be precisely determined, as it must vary according to the strength of the sunlight. A solution of medium color can be considered to be 0.3 grams of sulfur. cupric., dissolved in 900 grams of distilled water, to which 100 grams of ammonia water (4%) have been added. If one wishes to strengthen or dilute the solution, this is done by adding more or less copper sulphate; the amount of ammonia, however, should always be the same. A stronger solution than 3 times as strong as the above should not be used, as

too many chemical rays are then absorbed. If the light nevertheless heats too much, which is hardly likely to happen with a — lens of 25 cm. diameter, it is better to cover a larger area than to make the liquid bluer.



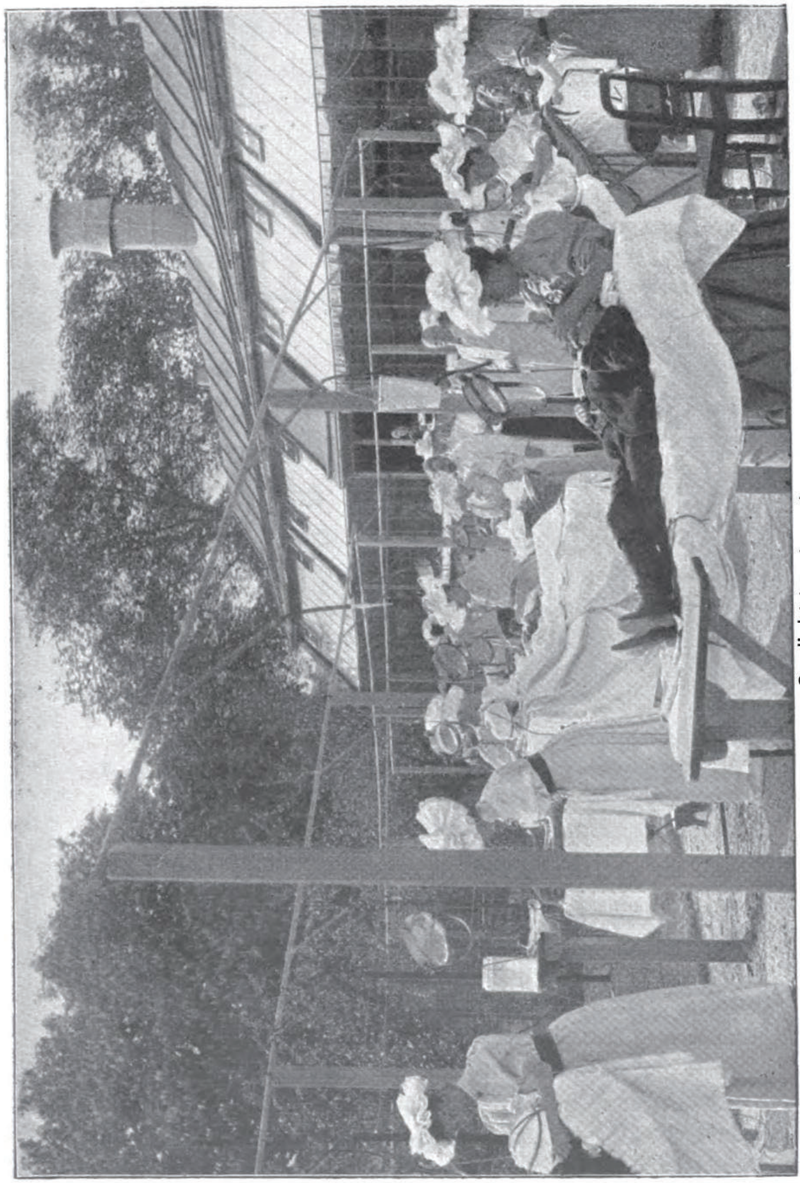
1/5 night. Size.

or smaller segment of Lindsen. I need not state any limit to the strength of the solution downwards, since it is of course most advantageous for the chemical rays to have the liquid as little coloured as possible. If the sunlight on some occasion heats it so little that the liquid can be made quite clear, it only means that one with greater

It would be advantageous to use a lens with a larger diameter and with blue-colored liquid.

In addition to these devices, the sun treatment also requires small tables, which should preferably be firmly fixed and have a top that projects freely to the north (since the table legs interfere with the positioning of the patients), as well as a water line to the pressure glasses. Since it may be of interest to those who would like to take up this treatment, I will describe how the sun treatment is arranged here at the Light Institute.

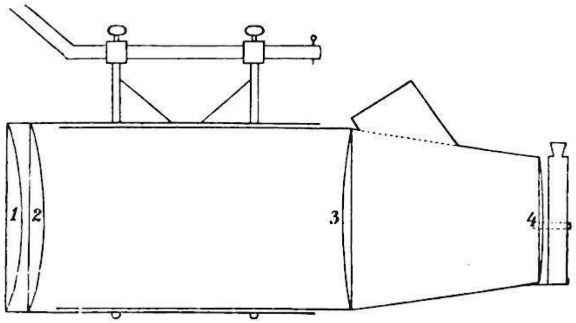
In the yard where the sun treatment takes place, two rows of small tables (28 in total) have been set up. The table tops, which are either round, with a diameter of half a meter, or square, are supported by a pole driven into the ground. The distance between the tables is 21/3 meters. Along the row of tables, up in the air, resting on supports 21/4 meters high, are placed water pipes, which, just above each table, give off a drain pipe equipped with a tap, from which a gutta-percha tube runs to the pressure glass. From this, a tube runs to a drain pipe placed under the table, which opens into a drainage channel running down into the ground. This water pipe, as well as the one for the treatment with electric light, caused me some difficulty at first, as the water pressure was too strong; but now that I have arranged it so that the water pipe is not directly connected to the city water pipe, but comes from a tank placed at a height of about 3 m. (up in the ceiling above the treatment room), it works very well and easily. The tank has a supply pipe that is provided with a tap with a float, so that it is always kept filled to a certain height. In the bottom of the tank there are drain pipes that supply both the solar treatment water pipe and the water pipe for electric light treatment. For safety reasons, the tank is provided with a drain pipe near its upper edge, in case the tap or float does not work.



Sunlight treatment.

Collectors for electric light.

These devices, like the solar collectors, have also undergone some changes in the past, but not as many as those. The most important and significant change is that, after an experiment (mentioned on p. 5) in May 1897, I introduced lenses exclusively of rock crystal instead of glass. But since before this experiment in



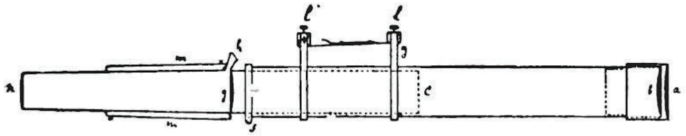
1/10 night. Size.

For some time, glass collecting devices of a somewhat different construction than those described on page 25 had been used for the treatment of lupus patients, and since I have not yet described them in any Danish treatise, I consider it most appropriate to give a brief description of them.

As can be seen from the accompanying drawing, which shows such a collecting apparatus on average, the difference between this and the one mentioned above is that there are 2 plano-convex lenses closest to the light instead of 3, and that the water layer is limited by two also plano-convex lenses. The lenses are of considerably larger diameter (25 cm. instead of 17) and the water containers hold about 10 liters of water. While the water container in the first apparatus was filled with the blue solution, in the latter it was filled with clear water, while the blue solution was placed in a "light filter",

c: a flat glass container, which was placed in front of the lower lens. There were several such light filters with different strong resolutions, so that by changing them one could quickly and easily make the light more or less warm according to the patients' wishes.

However, we had not had these relatively good devices for very long (10 months) before the introduction of devices with rock crystal proved necessary. As can be seen from the above studies, these devices had to be



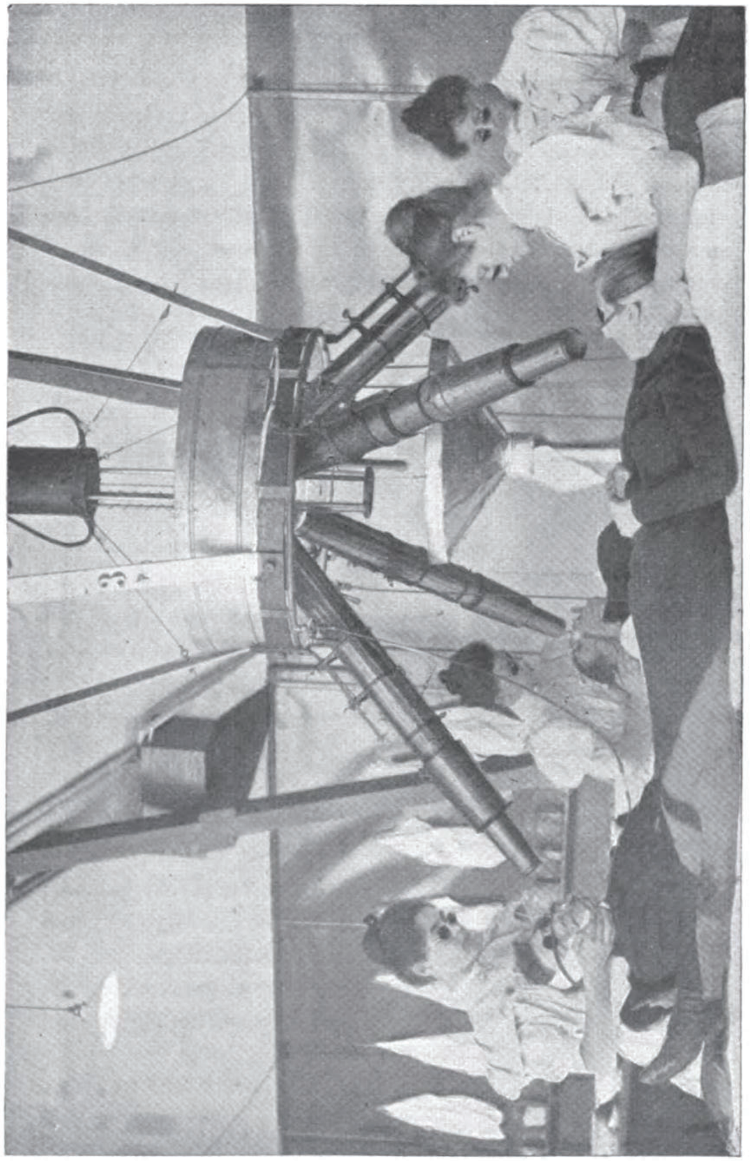
1 10 night. Size.

only rock crystal and only clear water are used. The change that was necessary from the form just described, which had otherwise proven to be very practical and good, was in particular that the light filter was dropped, and that the metal tube became of much smaller thickness, instead of 25 cm. in diameter it was now only 7-8 cm., because rock crystal lenses of larger diameter are difficult to obtain. By this change, the collecting apparatuses, as is evident from the accompanying average figure of the apparatuses now in use, have come to resemble binoculars, a comparison that is so natural also because the two metal tubes, like in binoculars, can be pulled out and pushed into each other. While the mutual position of the lenses corresponds entirely to the described apparatus with glass lenses, the long, thin shape of the apparatus has caused some differences. On the one hand, I have been able to make the water layer very thick (c. 35 cm.) without any disadvantage, and on the other hand, I have had to take special measures to center the apparatus in relation to the light point.

Since it cannot be avoided that the point of light, even if the lamp burns with a so-called fixed focal point, changes position in 3 small degree, — whether it is caused by the coals burning a little irregularly, or by the lamp moving a little - the result will be that the light falls a little crookedly into the tube, and since the path through it is so long and the tube so thin, it gives a large deflection at the lower end of the tube, where the light comes out. To compensate for this, it is first necessary, with the help of guy ropes and a so-called "fence wire tensioner", to fix the lamp as well as possible in the center of the ring that carries the 4 collecting devices (see picture p. 36); but then also to hang the devices in such a way that they can be centered. This is done with the help of 3 screws, which are located at the lowest suspension point of the device on the arm of the stand, while the center around which it rotates is located at the upper suspension point.

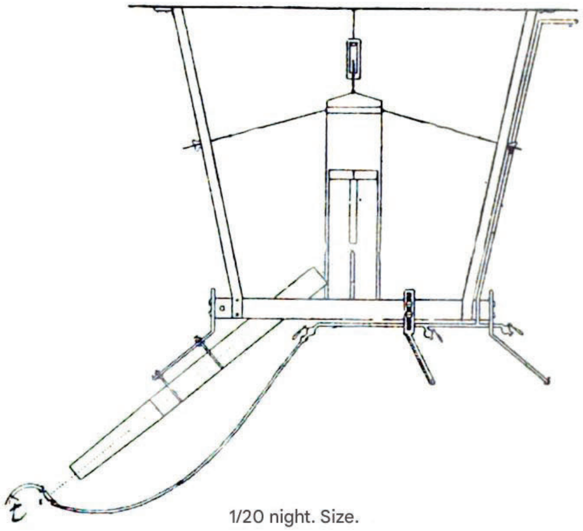
In the latest rock crystal collecting devices, the upper half of the tube containing the water is provided with a double wall, through which cold water can be passed and thereby cool the water inside the container without changing it. The water inside the container must be distilled water, while the cooling water is ordinary water. The reason why I have placed such a "cooling jacket" on the devices is, as is apparent from my above-mentioned experiments (p. 16), not that the water absorbs heat rays better when it is cold; but rather that the water in the devices often becomes very hot, and if a lens were to burst, the hot water would flow down over the patient and possibly scald him; furthermore, it is quite likely that the devices will leak more easily when the water becomes very hot. Since for other reasons (as mentioned on p. 22) a water pipe had to be established for the treatment, it did not cost much trouble to cool the collecting apparatus at the same time.

The last change made to the apparatus is that the tube forming the water container has been designed to be separated in the middle into two parts, the two parts being screwed together.



Treatment with electric light.

together and kept watertight by an interposed gutta-percha ring. Even better, however, is what we have recently introduced, to separate the tube in two places, immediately at the two lenses which close the tube.[1]) This is done to facilitate the cleaning of the inner surface of the two rock crystal lenses which limit the water layer above and below. That a very careful cleaning and frequent changing of the water in the



1/20 night. Size.

The necessity of the holder turned out to be quite amusing; in the beginning we only cleaned the lenses once a week, but it soon became noticeable that the reaction of the patients was often strongest the day after this cleaning, and it now appeared on closer examination that a frequent and

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1) This change was proposed — simultaneously but independently by me.
by Professor v. PETERSEN from St. Petersburg.

Pleasant cleansing is a necessity if one wants to obtain the full benefit of the light.

Very recently I have also provided the apparatus with a metal cover which closes off the lower part of the tube, where the light comes out. The cover resembles those used to close off a photographic camera; the only difference is that this cover is provided with a number of small holes. The purpose of this cover is to make it more convenient for the nurses to "adjust" the patients. Through the many small, regularly distributed holes, minimal amounts of light come through, whereby the same light image (focal point) appears as otherwise, only quite dimly, so that one can easily bear to look at it without dark glasses. The adjustment is done in this way much easier and more accurately, and only when the diseased part is in the right position to the light, and everything is in order, is the cover removed, and the full, strong light now falls on the patient. However small this improvement may be, it represents a very great advantage both for the nurses and for the patients, who were previously much disturbed by the strong and burning cone of light during the adjustment. These perforated sheets are also very useful in centring the apparatus; when you hold a piece of paper immediately in front of the sheet, you will see all the holes as small bright spots, and if these spots are not equally bright over the entire periphery, the apparatus is not well centered.

From the accompanying pictures you will see the way the apparatus is suspended, the position of the patient, etc. A couple of years ago, the stand that carries the apparatus was changed so that it is not supported by — supports that are fixed to the floor, but by supports that extend from the ceiling; this achieves both greater stability and better space for patients and nurses.

What is the difference between sunlight and electric light, and when should one use one and when the other?

The difference between sunlight and electric arc light, which has practical significance for us, can be briefly expressed as follows. 1) Sunlight contains relatively more heat rays in relation to chemical rays than does strong electric arc light. 2) The chemical rays of sunlight have their maximum at a different place in the spectrum, namely nearer the red end, than the electric arc light.

The theoretical conclusion that can be drawn from point 1 is that the electric arc light is better suited for this treatment than sunlight. Since the conditions for and the means for removing the heat rays are the same and identical for both types of light, according to this, with the same degree of heat at the focal point, one will get a stronger — chemical effect from the electric light cone than — from the solar light cone.

The degree of heat in the focal point of the light cone is the decisive factor when it comes to how strong light it is possible to use for treatment. For we do not yet know of any reason that speaks against using even the strongest possible chemical light for treatment, and until we learn of such a reason, one must of course strive to reach higher and higher in the direction of the strength of the chemical rays. However, it must be added here immediately that the chemical rays must be of the kind that have the property necessary for therapy of being able to penetrate well into the depths (see more about this later).

While the temperature at the focal point of the light cone that could be tolerated by the patients without water irrigation of the pressure apparatus was about 50° C., after the introduction of water irrigation, as mentioned, it rose to a little over 200° C.

With the latter degree of heat as the upper limit, one can therefore try to determine how strong the light can be.

use. As for sunlight, it is not so easy to get a definite measurement, since sunlight is so different at different times of the day and different seasons. As said above, I will assume, however, that lenses of about 25 cm diameter are most suitable.

As for the electric light, one can come somewhat closer to the determination. Experience has shown that with the ordinary arc light (carbon electrodes) and with my above-mentioned collecting apparatus, one cannot use stronger light than about 70 Amps. At 80 Amps, the light cone becomes so hot that many patients could not tolerate the treatment.

A more detailed comparison of these two kinds of light will appear later, together with the assessment of the various other light sources and the various treatment devices. Here I will only mention a few details from which one can roughly see the difference.

After the studies that we have done on bacteria, I would assume that under otherwise the same conditions, it would take a couple of minutes to kill Prodigiosus in plate culture with strong sunlight, while with electric light you only need a couple of seconds to do so. With regard to the visible effect on the skin, I cannot give such definite figures; in general, I can only say that the daily experience of treating patients shows that they get a much stronger skin reaction to electric light than to sunlight. It can certainly be said that sunlight does not usually cause blistering, while with electric light blistering is the rule (the treatment time is 5/4 hour). Incidentally, with regard to this question I would refer to my dissertation ("New Studies on the Effect of Light on the Skin". Messages from the Finsen Medical Light Institute. I. p. 6). Herein (p. 12) is mentioned a comparison of two experiments on my arm with unconcentrated sunlight and unconcentrated electric light, the results of which

The result was that the inflammation that appeared on my skin after 3 hours of exposure to sunlight (the experiment was carried out from 12-3 in the first half of August) was not as strong as that which appeared after 20 minutes of exposure to electric light (80 Amp. lamp, 50-75 cm. distance).

From what I have stated here, one will get a fairly clear picture of the superiority of electric light, and yet it is strange enough that we at the Light Institute have not received any definite impression, in the case of lupus treatment, that the results of the treatment are worse during the time when there is a lot of sun treatment than in the winter, when we do not use the sun at all; on the contrary, we have, at any rate in the past, been inclined to attribute to sun treatment a more favorable effect on the patients and a more favorable course of the treatment. 1). If this estimate is correct, we are faced with an apparent difficulty in explanation; but only apparently, for the probability suggests that there is another factor here that must be taken into account, namely the general condition of the patients. And that the general condition of our lupus patients is better in the summer than in the winter is a certain experience. This is probably partly due to the same reasons that are the reason why summer is generally the most favorable time for patients with tuberculous diseases, but it is perhaps not least due to the fact that local sun treatment is combined with a stay in the open air and sunshine and is thus a kind of general treatment in sunlight. Moreover, it must be remembered that it is a common experience - it is something we still hear from our lupus patients - that the local affections often spontaneously improve in the summer and worsen in the winter. For these various reasons, it is therefore not surprising that sun treatment apparently gives — just as good or even better results.

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1) This perception, which is a pure illusion, must now probably be changed somewhat.

results in Lupus vulgaris than the stronger electric light. The situation is quite different, however, with the other skin diseases which we have successfully treated with concentrated light. Both in the treatment of Lupus erythema-tosus, Alopecia areata, and in telangiectasia, electric light shows its superiority to such an extent that it is perhaps best not to treat these diseases with sunlight at all 1). This difference in the effect on these different diseases is in itself quite characteristic and may perhaps be interpreted with some justice as a sign of the importance of the general condition for the improvement or cure of Lupus vulgaris"). The practical consequence of this difference in the effect of the two kinds of light - a difference which, however, it must be remembered, was not present in the first years of this method, but is a consequence of the introduction of rock crystal — instead of glass - is of course that we now use sunlight much less frequently than before. The use of sunlight is restricted to the brightest part of the year (May-September) and the brightest part of the day; in general we now only use sunlight when the weather permits treatment in the open air. The fact that we do not use sunlight in winter or at all when the sun is low is also justified by the circumstance that sunlight when the sun is low is not only absolutely, but also relatively poorer in chemical rays than when The sun is high. This is due to the atmosphere, which has

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1) It is, however, possible that better results could be achieved with very long sessions.

After this was written, I have come to think that this relationship could perhaps be explained in another way and based on the difference between the two kinds of light (0: the different position in the spectrum of the There is much to suggest that we chemical rays maximum). 2) have unfortunately not yet been able to investigate more closely that the less refractible the rays are, the more — easily they penetrate the tissues in depth. The explanation could therefore be that sunlight has a stronger effect in depth than electric light.

the property of absorbing far more chemical rays than heat rays. By looking at the tables of the intensity of the sun's rays in Copenhagen, calculated by the Light Institute's physical employee, cand. mag. ABSALON LARSEN [1]), one gets a good impression of the extent to which this is the case. A few figures will best show this. If we take the value of the heat effect of the direct sun's rays on June 21 at noon to be 74, it is 34 at 7 in the afternoon; if we take the value of the chemical intensity on the same day at noon to be 119, it is only 5 at 7 in the afternoon. On December 21 at noon we have approximately the same solar altitude as on June 21 at 7 in the afternoon, and the figures are therefore approximately the same, namely the heat effect 33 and the chemical intensity 4.

At first, and before I knew these figures, I thought that the lesser power of the sunlight in winter could be compensated for by using larger lenses, but by testing the chemical effect of the cone of light, when it was as strong (5: hot) as the treatment allowed, it turned out that the chemical intensity was extremely small; but only after the exact tables were available was I able to clearly see the conditions.

Even if one did not have precise physical studies of these conditions, one could nevertheless conclude that by immediate assumption. As is known, the sun is red when it is near the horizon and becomes whiter and whiter the higher it rises in the sky. This shows that the red rays, the heat rays, are in such an extraordinary predominance when the sun is low. Conversely, the color of the sun actually becomes more and more bluish the less atmosphere the light has to pass through, so that its color, if one could observe it from a point outside the atmosphere, would appear blue (Langley).

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[1]) ABSALON LARSEN: The Intensity of Solar Rays, Reports from Finsen's Medical Light Institute I p. 121.

With regard to our use of light, the difference between the two types of light has the technical significance that, as discussed in detail above on pp. 7-8, it is most advantageous to use rock crystal lenses for collecting devices for electric light and glass lenses for collecting devices for sunlight.

What possibilities are there for improving the method?

Already in my first communication about this method I strongly emphasized that there was a certain possibility of extremely great improvement of the method, both in the direction of better apparatus and in the direction of better light. Although in the past 6 years as I have described above very great improvements have been made both with regard to the light and with regard to the apparatus, especially the latter, there is no doubt that the method can still be improved and will be improved considerably. I will briefly indicate in which directions the development must be assumed to go.

The improvement of light will consist in providing light that is as rich as possible in chemical rays and as poor as possible in heat rays.

With regard to sunlight, an "improvement" can only consist in seeking those times and places where the sunlight meets the given conditions to a particular degree. I have touched on this question above (p. 41) and shown that sunlight in our latitude is only suitable for light treatment at certain times of the year and at certain times of the day. One must of course be familiar with these conditions when one wants to use sun treatment. The location of the place is also of great importance.

We know that the atmosphere preferentially absorbs the chemical rays; therefore, sunlight will be much better suited for action in places where the air is light and clean, while places where the air is filled with dust particles or water vapor are less fortunate. For these reasons, sunlight is usually stronger on land than in large cities with their smoke-saturated atmosphere, and stronger inland, where the air is relatively dry, than by the sea, where it contains much more water vapor.

Of greatest importance, however, is the height of the place above the water surface; the higher the location of a place, the thinner the layer of air through which the light must pass, and the greater the chemical intensity of the light. There is also the advantage that the air temperature at high altitudes is not as high as at lower altitudes at the same latitude. The heat is of great practical importance. Even here in Denmark, when undergoing sun treatment on hot summer days, it is difficult enough for both nurses and patients to endure the heat in the middle of the day. The further south one goes, the worse it naturally becomes. In Greece, for example, it has been found that sun treatment must be postponed for this reason to the morning hours, while the sun is still low; however, this is unfortunate, since the chemical intensity of sunlight, as mentioned above, decreases relatively strongly with low sun altitude.

The discomfort caused by the heat in this way is actually so great that one can practically say that there are more favorable conditions for sun treatment in the northern countries than in the southern ones. If one could make such arrangements that nurses and patients were shielded from the sun and not suffer from the heat, while still receiving direct sunlight on the sun apparatus, that would be another matter.

It will be seen from this that if there is talk of establishing a larger phototherapy facility or a sanatorium for lupus patients, especially in the southern countries, it will be very

It is expedient to place it on a high place. And besides, apart from the great economic importance of using sunlight rather than expensive electric light, there is the advantage that in such a place, due to the great chemical intensity of the light, one will probably be able to achieve quite different favorable results than we have been able to achieve with sunlight in this country. The idea of establishing such an institution or sanatorium for skin tuberculosis on a mountain cannot seem so daunting at the present time, since sanatoriums for pulmonary tuberculosis are being established on mountains. Perhaps it would be most natural and easiest to establish such lupus treatment institutions in connection with mountain chest disease sanatoriums, especially since these often already have electrical installations for lighting. Cooperation would be easy here and could perhaps even be done without any additional electrical system, since the light treatment on days when there was no sun could be carried out during the day, when electricity was not used for lighting anyway. At the same time, there would be a good opportunity for the not few lupus patients who also have pulmonary tuberculosis to undergo a curative pulmonary tuberculosis treatment. This combination of lupus treatment and phthisis treatment is already carried out in practice here at the Light Institute, since, on Dr. BANG's initiative, we have set up a lounge for the chest-sick lupus patients; at the same time, we have also strived to improve their nutritional status by distributing milk and hematin-albumin to poor patients. (Since the patients do not live at the Institute, we could only partially take care of their nutrition).

This proposal for mountain lupus sanatoriums is admittedly a little outside my subject, but may perhaps have some practical interest now that so much can be done, and that therefore hopefully something will also be done for the unfortunate people who suffer from lupus, in the same way as is done for those with chest diseases. And that the disease in most countries is common sufficiently common and widespread enough to justify such extensive measures, there can be no doubt about it, after we have learned how widespread it is in Denmark, which is not, however, a particularly tuberculous country.

But to return now to the subject: the possibility of improvements in the light source, we are quite differently free to make improvements when it comes to artificial light. Since this is of such great importance, we have been working on this task for some time now. The investigations were first aimed at 1) determining, by a comparison between different types of arc lamps, which one was best suited for us. Next, it was a question of determining 2) whether the light from the arc or from the coals was the best, and finally 3) at what voltage the light was best for our use. For the determinations we have used partly chemical reagents, silver chloride paper and silver bromine paper, and partly bacteria. These latter are absolutely the best and most practical means of determining the intensity of the light, since it is precisely the intensity, or rather the type of light, which kills bacteria that is important to measure. By a long series of investigations of this kind, which I will not go into in detail here, we have found that the ordinary arc lamp in the form which we use at present, and which is partly constructed for our use and according to our requirements, is preferable to the others which we have tried.

To investigate whether the light from the arc or from the glowing positive carbon tips was the most bactericidal, I formed an image of the arc and carbon with the aid of a collecting lens of rock crystal, and let it fall on a plate culture of B. prodigiosus. The next day the culture showed, quite like a photograph, which parts of the light had affected the bacteria most strongly. The least influence was found where the arc had been, a little stronger for the negative carbon, but far stronger for the positive carbon. (This does not mean, however, that the relationship is not

may turn out to be different with a different type of arc lamp).

The studies with regard to the voltage showed that the voltage that was most favorable for the lamp (c. 50 volts) also produced the most bactericidal light.

The changes which we have made to the lamp, really only concern its external form; thus the distance between the side rods has been made very large, so that they should take as little light as possible from the apparatus. In order that the regulating mechanism of the lamp should not be heated too much, an asbestos screen has been placed over the coals. Furthermore, the lamp is arranged in such a way that it can be lashed absolutely firmly in the middle of the ring which carries the apparatus.

The reason why I have mentioned these studies so briefly is that the Lighting Institute has recently been working diligently on new lamps with different types of electrodes.
These lamps seemed at first to promise good things, but have not lived up to expectations. They have, however, taught us that more detailed investigations are needed into the ability of the individual types of radiation to penetrate through heat, and that it will be of little use to continue working on new lamps before this question is fully elucidated. But, as it is, all probability indicates that the future will bring better lamps than those we use at present, since the lamps we use are designed for the purpose of lighting, but not for the purpose of causing inflammation and killing bacteria. When it first becomes clear to those experts in this field that they must design something new for medical use, then it will most certainly come.

The second way to improve the method is through improving the apparatus. I have said something about these in the preceding section and will therefore be brief here. Although the forms which we use at present have emerged as a

The result of extensive research, however, would be quite unreasonable to believe that they could not be improved in many ways, - both solar apparatus and electrical collecting apparatus and printing apparatus, but in what these — improvements should consist, it is not so easy to say at the moment. One of the most natural improvements, which we have already been experimenting with for some time, is to try to treat a larger area at once, i.e. to arrange the apparatus and lamps in such a way that the spots of light become larger without the intensity of the light becoming less. With the ordinary apparatus with lenses of 7 cm. diameter, one would thus be able to develop a spot of 7 cm. diameter, instead of 11/cm. diameter as now, if one inserted flat rock crystal plates in the lower tube instead of collecting lenses. In order to achieve the same effect, of course the intensity of the light must at the same time be increased very considerably. Such an enlargement of the light spot would be very beneficial in widespread cases, but would be quite unnecessary in less widespread cases. It will therefore probably be the case that one gets devices with light spots of different sizes at the same time as we already have the arrangement to have light spots of different intensities.

A very practical improvement has recently been invented by Dr. REYN. Since the lens closest to the light frequently cracks, Dr. REYN has found the solution of using water cooling for this lens. This is done by placing a flat rock crystal plate about 2 cm in front of the front lens. In the space thus created there is distilled water which is cooled by a water current constantly circulating around it. This not only prevents the expensive lenses from cracking, but also allows the entire apparatus to be placed closer to the light, and this is therefore better utilized.

Application of the method in practice.

While in the foregoing I have dealt exclusively with the physical part of the method, I will now proceed to give a description of the application of the method in practice and an account of the therapeutic results achieved so far with its help.

As is evident from my first publication of this method 1. c. pp. 45-46, I was aware from the very beginning of the great development possibilities that lay in it, both with regard to its technique and with regard to its therapeutic area, and even though several of my assumptions and opinions have proven to be incorrect (e.g. I believed at the time that one could achieve an enormous amount by using very large lenses, which, as mentioned above, has proven not to be the case), it has nevertheless turned out, on the whole, that I have not been disappointed.

At that time (1896), I was — afraid that the method would be judged by the relatively good results achieved at that time, and I stated the following 1. c. p. 45: "A judgment on the method from the present standpoint will therefore be quite incorrect. Until experiments have been made with very bright light and the best possible apparatus, one will not be able to form any definite opinion about its real value." The question then becomes whether we have now reached that point, or at what point in time we reached that point, that the conditions set could be considered fulfilled. To this I would reply that I cannot consider the method to be even fairly fully developed before the introduction of the rock crystal apparatus and the large arc lamps of 60-70 Amp., which was not fully implemented until June 1898. The period before, that is, from November 1895 to June 1898, must be described, and I will describe it in the following, as the experimental stage. The separation of the experimental stage from the later stage is given by its most important significance when it comes to the results of the treatment, while it plays virtually no role in the technique or execution of the treatment, which I will now discuss first.

Execution of the treatment.

No very significant changes have been made to the design, and the description I have given on 1. c. pp. 39-41 therefore fits quite well. The following changes have occurred.

Each area is now only treated for 5/4 hours instead of 2 hours, and yet the effect is now much stronger than it was previously after the two hours. This time (the 5/4 hour) is not an absolute, however, it is what we currently use for Lupus vulgaris, but it is very likely that experience will gradually show that the other diseases that are successfully treated by this method could either be satisfied with shorter or should have longer sessions. Possibly, in the case of Lupus vulgaris, too, one will gradually come to individualize the duration of the session, as there is a considerable individual difference in the strength of the skin reaction. At present, we individualize in such a way that the patients, according to their tolerance for the light, are placed either by the strongest or weakest lamps that we use, respectively 70 Amp. and 45 Amp., and that they sometimes have 2 sessions in a row at the same area.

At first I let each nurse look after only one patient, although I hoped later, when they became more experienced, to be able to let each nurse look after two patients; I tried this for a while, but gave it up again, as I felt that what was gained in economic terms was lost in the more inadequate care. And now, after the introduction of the long, thin rock crystal apparatus, which often has to be adjusted, and of the

The pressure glasses with water irrigation, I consider it very wrong, if the care of the Ptt. is to be satisfactory, to let one nurse care for more than one Pt. To this is added the circumstance that the nurses can rarely leave the pressure glass entirely to the elastic bands with which it is attached, but must hold it in the right position and often exert pressure on it with their fingers, which will be impossible when the person concerned is caring for two Ptt.

A greater difficulty than one would think has been connected with finding a suitable way of placing the PTT. You may think that this point is of such secondary interest that I could easily pass over it; but in reality it is of great practical importance that the treatment is not felt to be difficult and difficult by the patients. You will understand that it is often difficult to bring the various diseased areas, especially the face and neck, under the cone of light, so that the light falls more or less perpendicularly on them and so that the head is not turned into an uncomfortable position at the same time. Since a session lasts 5/4 of an hour, and one must keep the head in the same position during that time, it is of course important that it lies comfortably. This, quickly and easily placing the patient in a correct and comfortable position for the light, is one of the most important but also most difficult tasks of our nurses. The most practical has proven to be placing the PTT. on beds (of the type used in hospitals for dressings) with adjustable headboards. The finer adjustments of the head to bring the affected area under the focal point of the light cone are then made with the help of pillows of various shapes.

In many cases when the patient can be treated most easily in a sitting position or prefers to sit, we use rocking chairs to great advantage, as they can be adjusted with the help of wooden blocks that are inserted under the legs. One could probably 4 construct special chairs that would be even better and that would be adjustable in all directions, but they would be much more expensive and would hardly be useful in comparison.

The Effect of the Treatment.

Since phototherapy already covers a considerable number of skin diseases and is still bringing more and more under its control, the description of the treatment and its effects should have a general character. However, since our experience with lupus vulgaris is many times greater than with all the other diseases combined, I would prefer to give a detailed description of the treatment and the effects of this disease as a paradigm and then later, when discussing the other diseases, add if there is anything special to mention.

The treatment currently takes place in such a way that a small round spot (2-3 cm. in diameter) is illuminated for 5/4 hours every day. So that the nurses do not make a mistake about the location, and so that the light cone always aims precisely at the same spot, the doctor usually draws a ring around the spot to be treated with a dermatograph before the treatment begins. Since we have received the powerful rock crystal devices and the strong light, the same spot is usually not treated for several days in a row as before, provided that there is enough diseased tissue for one to choose another spot. The reaction is often so strong that it is not easy to do. However, there are great individual differences here, for while some of the patients who have such a small lupus that there is only room for one spot can tolerate treatment on it for many days in a row, others must take a break of one or more days between each treatment.

The visible effect of the treatment on the skin is a strong redness at the site, and the spot rises in level above

the surrounding skin; there often occurs, one might say most often, a vesicle formation at the site. The time of its appearance varies somewhat, from 16-24 hours after the illumination. This vesicle formation, which is sometimes of smaller, sometimes of larger dimensions, closely resembles the vesicles after vesicatories. Vesicator formation occurs much more frequently and strongly after electric light than after sunlight. Occasionally the reaction at the treated site is so strong that there is slight edema of the surrounding skin, especially if the spot is in the vicinity of the eyes. Incidentally, the size of the skin reaction can as a rule be considered as a measure of the strength of the apparatus and the light; if the reaction is very weak, there is reason to believe that there may have been something wrong with the lamp or the apparatus; in this way, as mentioned above, we have learned that the apparatus needs to be cleaned very often. Another practical interest of the reaction is that it can be used to check whether the nurse has been careful or not; if, for example, the spot is very blurred, or there are perhaps two red spots on the skin, this shows that the cone of light has not been kept in the same place during the entire session.

The further course of this skin reaction is that the vesicle dries up and forms a crust, which falls off after a few days, whereupon one sees the new epidermis formed over the entire extent of the spot. This relationship is constant. The phototherapy therefore does not cause any necrosis of the skin, and no scar tissue is formed or appears as a result of the treatment; the new epidermis is formed if vesicle formation has occurred simultaneously from the entire base of the spot. In my first dissertation 1. c. P. 41 I mentioned that I had seen necrosis a couple of times after phototherapy, but that this was due to a pure burn; I must add that we have only seen the same thing once later. However, when one considers that necrosis of the lupus tissue is something that which is precisely what is intentionally caused by various earlier methods of treatment, it would be unreasonable to attribute any particularly unfortunate significance to these individual cases, which are as a rule caused by the patients' lack of adaptability, since they have not reported that the candle "burned".

I would like to add here that I have deliberately used this condition a couple of times as an experiment. These were isolated lupus nodules that had been very resistant to light treatment; I now suggested to the patients that we should try to burn them away with the light cone, that is, use the heat of the light at the same time as the chemical rays. By pressing hard with the pressure device, the process became less painful, and Ptt. endured it quite easily. But the result did not correspond to my expectations; on the contrary, the affection seemed to disappear and spread, and when one adds to this the painfulness of the treatment and the loss of substance with the formation of ulcers, then in reality I obtained through these experiments further proof of the great advantage of using "cold" light.

An important consequence of the property of light treatment that it does not cause scars and can therefore be used on healthy skin without harm is, as I mentioned at the beginning 1. c. p. 43, that one can treat the apparently healthy, but possibly infected surroundings of the diseased area. In this respect, light treatment has an invaluable advantage over many other methods, which could otherwise be rational.

After the diseased part and the surrounding healthy border have been thoroughly treated, a change in the diseased parts is evident; any ulcerations heal, the surface becomes firm and smooth, and diaphanoscopic examination shows that the characteristic lupus nodules become fewer and fewer, and finally disappear completely. The skin, however, remains

For some time the treated areas are red, but gradually become pale and acquire a natural color.

This transformation process naturally takes a certain amount of — time, how long is impossible to say, since there is such an extraordinarily large individual difference here, and a certain amount of time must therefore pass before one can really see the effect of the treatment and see whether the healing is complete or whether there are still diseased points remaining. For this reason, in order to save time and unnecessary treatment, we have arranged it in such a way that when the diseased areas have been treated thoroughly and have apparently improved a lot, the treatment is suspended for one or more months. During this time, as a rule, a clear differentiation occurs between the healed and the not yet healed parts; Pt. is now put under treatment again, but this time as a rule for a much shorter time, then again a break and then possibly a new treatment, until finally there is no more disease left. It is of course not so rare that Pt. is completely healed after the first treatment; but the rule is that more treatments are needed, which is also the intention. How these conditions have arisen with us, I will discuss below in my statistics. However, it goes without saying that such statistics can only be valid for a single clinic or a single doctor, since much depends on how long and how thoroughly the first treatment was carried out. That there are many patients who have had to repeat the treatment numerous times, you will also see from the statistics; but this is also the most unfavourable thing that can happen. The treatment works as reliably in lupus vulgaris as one could possibly expect. The fact that there are nevertheless a few among our more than 800 cases where the effect of the treatment has been very poor, can perhaps not be blamed so much on the method as on other random circumstances.

Since it was my concern to ensure that the experiments with this new method were so pure from the very beginning that they left no doubt, I used exclusively light treatment in the treatment of the first 130 patients. Later 1) in a few cases we have used other older methods of treatment with advantage prior to the light treatment, galvano-caustics, ointment treatment (especially Pyrogallus ointment), etc. and then continued and concluded with light treatment. How frequently we have used this combined method is evident from the statistics below. The cases in which we have used this initial treatment have been particularly cases with thick spongy granulation formations, with strongly pigmented thickened lupus areas and the like. It has been shown that such a preliminary treatment has considerably accelerated the healing in many cases, it has smoothed the way for the curative light treatment. The cases which are most difficult for light treatment to overcome are, according to the nature of the matter, namely, the very thick and deep-seated affections, and the very pigmented forms. I must also add that we have only used these strong agents as a preliminary treatment in cases where the cosmetic result could not be affected thereby, and where this was of less importance than a rapid healing (e.g. on the trunk or extremities).

In the last couple of years, after the introduction of the rock crystal apparatus, and after the effects on the skin have become stronger and the formation of vesicles more frequent, we have, in order to protect these excoriations caused by the treatment, allowed the patients to wear boric water compresses, which, incidentally, also has the effect of softening the crusts and thereby making them

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1) After the spring of 1898, patient treatment was led by Dr. FORCHHAMMER as chief physician with Dr. REYN as permanent reserve physician.

diseased areas are better accessible for the light treatment. We also often use Diachylon and other healing ointments.[1])

(To be continued).

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1) Since the above was printed (it has been ready for a long time) a large number of new lamps and new treatment devices have appeared. I have not been able to include them here, but will in the following go into more detail about them and a comparison between them and my own devices.

ON THE ABSORPTION OF ULTRAVIOLET RAYS BY BLUE LIQUIDS

VALDEMAR BIE

As described on pp. 18 and 19 of Prof. Finsen's preceding treatise, the patients were originally treated with electric light, which was concentrated through glass lenses and cooled by passing through a blue, ammoniacal solution of copper sulphate. At the same time that the rock crystal lenses were introduced, this blue solution was replaced by distilled water, because it was shown in some preliminary experiments that the blue liquid absorbed ultraviolet rays, so that the advantage of rock crystal lenses was lost. However, it was in these preliminary experiments. Since it is of course of great importance to know for sure whether the chemical effect of light is so much impaired by passage through a blue solution that electric light thus cooled is useless in practice, I have, at Prof. Finsen's request, made a couple of experiments to investigate this matter more closely.

The light from an arc lamp of 25 amperes and 50-48 volts was concentrated through a Finsens concentration apparatus with rock crystal lenses. Its front lens was 7 cm. in diameter and 11. cm. distant from the carbon tips. To the end of the concentration apparatus facing away from the lamp was attached a small stand, on which the rock crystal dishes with the bacteria mentioned below were placed, and on which a brass plate was suspended in a hinge to open and close the light.

The concentrated light passed through a light filter, either of rock crystal or of glass, and filled either with distilled water or with copper sulphate solution (1/2% solution, to which for every 10 cm^3. 1 cm^3. of ammonia water was added). Both light filters had 25 mm. lumen. The glass plates were 2.7 mm. thick, the rock crystal plates 1.7 mm. The front surface of the light filters was 40 mm. removed from the nearest lens of the concentration apparatus. The light cone had a diameter of 25 mm at this point.

After the light had passed through the light filter, it struck the bacteria, which had been treated in the following way: A broth culture of B. prodigiosus (in the first experiment 15 hours old, in the second 18 hours old) was filtered through filter paper. 1 — cm^3. of it was diluted with 9 cm^3. of water. Drops of this suspension were transferred onto rock crystal plates, which were set in a brass ring, so that the plate and ring together formed a dish. A drop was placed on each plate; this was dried in a desiccator with calcium chloride. The bacteria were then illuminated under the conditions indicated above. The rock crystal plate was placed 130 mm. from the nearest lens; at this point the light cone had a diameter of 12.5 mm. During the illumination, cold water was constantly flowing over the side of the rock crystal plate facing the light; the bacteria were placed on its opposite side. After the illumination, I covered the dried bacteria with a drop of agar. Finally, the dishes were placed with the bottom (rock crystal plate) facing up on moist filter paper in a Petri dish, so that they formed a moist chamber.

By the strong dilution with water and by drying, I have succeeded in avoiding the very considerable source of error represented by the absorption of chemical rays by the nutrient substrates, a source of error which is so great that it was absolutely necessary to avoid it.

When a salt solution or bacterial suspension or similar dries, a narrow, raised rim forms in

The periphery of the dried drop. If you cover this with a drop of agar, as I have done in these experiments, and let the bacteria grow out, the growth will be denser in this rim than inside it. If the bacteria are illuminated, they are killed first on the small surface inside the rim, but later in the rim. The destruction of the bacteria in this raised rim takes place, as was to be expected, irregularly. In reading the experimental results, I have therefore only taken into consideration the part of the dried drop that lies inside the rim.

I. Rock crystal light filter with distilled water.

	Try I	Experiment II
1 Sec.	Growth	
2 -	do.	
4 -	do.	Growth
7 -	No growth	No growth
10 -	do.	die.
15 -		do.
20 -		die.

II. Rock Crystal Light Filter with Copper Sulfate Solution.

	Try I	Experiment II
1/4 Min.	Growth	
1/2 -	do.	
1 -	do	Growth
2 -	do	do.
4 -	No growth	No growth
7 -		die.
10 -		die.

III. Glass Light Filter with Water.

	Try I	Experiment II
1/4 My.	Growth	
1/2 -	do.	Growth
1 -	do.	do.
2 -	No growth	No growth
4 -	do.	do.
6 -		do.

IV. Glass Light Filter with Copper Sulphate Solution.

	Try I	For increase II
1/4 My.	Growth	
1/2 -	do.	
1 -	do.	Growth
2 -	do.	do.
4 -	No growth	No growth
7 -		do.
10 -		do.

The result of the experiments is that the bacteria are killed under the given conditions:

when the light has passed through rock crystal and distilled water in 4-7 seconds;

when the light has passed through glass and distilled water at 1-2 My.;

when the light has passed through rock crystal and copper sulfate solution in 2-4 minutes;

when the light has passed through glass and copper sulfate solution for 2-4 minutes.

The considerable difference I have found, as the light has passed through rock crystal with distilled water or glass with distilled water, is due to the absorption of ultraviolet rays by the glass. The difference between glass with distilled water and glass with copper sulphate solution is due to the latter's absorption of blue and violet rays. I have found no difference between copper sulphate solution in rock crystal and in glass. In other words, a copper sulphate solution of the indicated strength absorbs so many chemical rays that the advantage of using rock crystal instead of glass is lost when the light passes through it.

STUDIES ON THE EFFECT OF LIGHT ON SMALLPOX VACCINE

OF

NIELS R. FINSEN AND GEORGES DREYER.

The great influence which light has on the course of the skin affection in smallpox cannot but arouse our astonishment. First, there is reason to wonder that ordinary daylight can have such a powerful effect that the mere exclusion of its chemical rays is sufficient to prevent the appearance of one of the most terrible disease states (the suppuration stage) known to us. Second, there is every reason for us in our bacteriological age to wonder that it is precisely the exclusion of a bactericidal agent which has this effect in an infectious disease. If one were to draw the following conclusion: since smallpox is an infectious disease, it would seem rational to let the patients lie in bright light and preferably in blue light, since this is particularly bactericidal, then from a purely theoretical point of view one would not be able to object greatly to this consideration.

Such an objection has actually also been made to the treatment of smallpox by excluding the chemical rays of light. It was an English physician, Dr. MOIR, who in The Lancet [1]) against this treatment solely on the — without having tried it, wrote — basis of the above conclusion. Dr. M. ended his article with the words that in the treatment of smallpox it was precisely: "light, light, more light".

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[1]) John Moir. Treatment of small pox by exclusion of the chemical rays of daylight. *The Lancet* 29. Sept. 1894, p. 739.

However, experience gained has greater value than theories, and they have not proved Dr. MOIR right. Besides, the method was far from lacking a theoretical justification, it only had the fault of not quite agreeing with the prevailing bacteriological views of the time. That it was correct is now shown by the rather numerous and quite constant results which have been achieved by "red light" treatment, and there is nothing to do but admit that in the case of smallpox the inflammatory effect of light is of far greater importance than its bactericidal effect.

There was, however, still the possibility that the pathogens of smallpox could react differently to the effects of light than other microorganisms; at least some studies 1) carried out at the Vaccination Institute in Hanover seem to indicate this. These showed that if animal smallpox vaccine was enclosed in capillary tubes and then exposed to diffuse daylight or even sunlight for 2-8 weeks, the activity of the lymph nevertheless remained unchanged.

Since the solution of this question seemed to us to be of some interest, we have subjected it to renewed investigation.

EXPERIMENTAL DEVICE.

An electric arc lamp is used as the light source, and a Finsens concentration apparatus with lenses of rock crystal is used to concentrate the light.

The diameter of the positive and negative carbon was 2.4 and 1.5 cm respectively. The tip of the positive carbon was always 11.5 cm. away from the nearest lens in the concentration apparatus. New carbon (same length) was inserted at the beginning of each series of experiments. For all experiments the arc lamp burned with 25 amperes and 49-50 volts. During the experiments the direction of the light was always 45° below the horizontal plane, and the illuminated surface was perpendicular to the direction of the beam.

The animal smallpox vaccine used for the illumination (usually glycerin emulsion) has been very willingly given to the Lighting Institute by the Royal Vaccination Institute, just as the latter has also very willingly undertaken the no small task of carrying out the vaccinations with the illuminated vaccine, which latter is of the greatest importance, as considerable routine is required to obtain a uniform and safe effect. For all the courtesy shown, we therefore ask the Vaccination Institute and its director, Mr. Corps Physician, Dr. med. Bondesen, to accept our best thanks.

The vaccine to be illuminated was placed as a drop on a flat rock crystal plate, set in a brass rim, with the help of a platinum wire ring of 3.5 mm diameter. (The thickness of the platinum wire was 0.9 mm). The greatest thickness of the drop in almost all experimental series was c. 0.4 mm, except for experimental series 1 and 2 (c. 0.3 mm) and experimental series 12 and 13 (c. 0.5 mm). The drops were always placed in the middle of the rock crystal plate, on the side facing away from the light source. During the illumination, the dishes were placed in such a way that the center of the rock crystal plate was centrally located in the part of the light cone that contained the most chemical rays (tested with silver paper). The diameter of the light cone was here c. 1. cm.

During the lighting, the dishes, which were not provided with a lid, were sprinkled with cold water to eliminate the effect of heat.

Where experiments have been carried out with clear, blue or red

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1) Medical. extra. Mittheil. v. d. quay. Healthy County. Vol. 5, Issue 2, p. 94

*) The studies were carried out by G. DREYER.

3) Message from Finsen's medical institute. 1 1899 (Jan.) p. 54-80.

Glass, in order to exclude certain parts of the spectrum, this is done in such a way that one of the mentioned glass plates is placed between the light source and the rock crystal plate. Both plates are sprinkled with cold water.

After the illumination, vaccination has been carried out from each drop on a child with 3 scratches on the left arm; on the right arm of the same child, in all cases, control vaccination has been carried out with unilluminated vaccine from the same glass tube as that used for the illumination. The control vaccinations on the right arm (also 3 superficial scratches) have in all cases resulted in the development of 3 vaccine pustules (1 for each scratch) of normal typical shape and size (5: strong impact), which makes these control vaccinations particularly suitable for use for comparison. The inspection of the vaccinated children has been carried out the week after the vaccination.

Vaccine from 11 different calves was used for the experiments. The age of the vaccine varied from 1-4 weeks.

The same series of experiments was always carried out on the same day with the same vaccine, and the individual experiments were carried out in immediate succession. The abbreviations used in the attached tables are as follows:

3 Vaccine pustules of normal size 2: strong impact.
3 — of less than normal C. 2: medium-strong attack.
3 — of small Size 2: weak Impact.
— 3 of insignificant Size 2: abortive Estimate.

Trial Series I: Vaccine from Calf 26. Age of the Vaccine: 15 days. Lighting by rock crystal. Maximum thickness of the drop c. 0.3mm. Inoculation of 9 children.

Forseg No.	Lighting time	Child No.	Number of Scratches	Result of the Inoculation
1	1 Sec.	1	3	Strong impact (3 pustules)
2	2 .	2	3	„ „ (3 P.)
3	3 „	3	3	„ „ (3 P.)
4	5 „	4	3	„ „ (3 P.)
5	10 „	5	3	medium A. (3 P.)
6	25 „	6	3	„ „ (3 P.)
7	50 „	7	3	abortive A. (3 P.)
8	100 „	8	3	no estimate
9	200 „	9	3	no estimate

Trial Series II: Vaccine from Calf 30. Age of the Vaccine: 15 days. Lighting gj. Rock crystal. Thickness drop c. 0.3mm. Inoculation of 9 children. The largest

Forseg No.	Lighting time	Child No.	Number of Scratches	Result of the Inoculation
1	1 Sec.	10	3	Strong impact (3 pustules)
2	2 „	11	3	„ „ (3 P.)
3	3"	12	3	„ „ (3 P.)
4	5 „	13	3	„ „ (3 P.)
5	10"	14	3	medium A. (3 P.)
6	25"	15	3	„ „ (3 P.)
7	50 woo	16	3	no estimate
8	100 „	17	3	no estimate
9	200"	18	3	no estimate

Trial series III: Vaccine from calf 37. Age of vaccine: 16 days. Lighting: rock crystal. Maximum thickness of the drop: c. 0.4 mm. Inoculation of 9 children.

Forseg No.	Lighting time	Child No.	Number of Scratches	Result of the Inoculation
1	50 Sec.	19	3	Medium Impact (2 Pustules)
2	50 „	20	3	„ „ (1 P.)
3	60 „	21	3	„ „ (3 P.)
4	60 „	22	3	„ „ (2 P.)
5	75"	23	3	weak A. (3 P.)
6	75 „	24	3	„ „ (3 P.)
7	100 „	25	3	abortive A. (1 P.)
8	100 „	26	3	abortive A. (1 P.)
9	100 „	27	3	abortive A. (1 P.)

Trial series IV: Vaccine from calf 37. Age of vaccine 23 days. Lighting by rock crystal and red glass. Maximum thickness of the drop c. 0.4 mm. Inoculation of 6 children.

Experiment No.	Exposure time		Child No.	Number of Scratches	Result of the Inoculation
	Rock crystal	Red Glass			
1	75 Sec.		28	3	weak impact (2 pustules)
2	100 „		29	3	medium A. (2 P.)
3	150"		30	3	weak A. (2 P.)
4	200 „		31	3	no estimate
5		15 minutes	32	3	strong A. (3 P.)
6		30 „	33	3	strongly A. (3 P.)

Trial series V: Vaccine from calf 37. Age of vaccine: 26 days. Lighting: rock crystal. Maximum thickness of the drop: c. 0.4 mm. Inoculation of 2 children.

Forseg No.	Lighting time	Child No.	Number of Scratches	Result of the Inoculation
1	120 Sek.	34	3	abortive stroke (1 pustule)
2	120 „	35	3	no estimate

Trial series VI: Vaccine from Calf 39. The vaccine Age: 10 days. Lighting: rock crystal. Maximum thickness of the droplet: c. 0.4 mm. Inoculation of 4 children.

Experiment No.	Lighting time	Child No.	Number of Scratches	Result of the Inoculation
1	100 Sec.	36	3	abortive stroke (1 pustule)
2	100 „	37	3	„ „ (1 P.)
3	200 „	38	3	no estimate
4	200 „	39	3	no estimate

Trial series VII: Vaccine from Calf 2. Vaccine Age: 16 days. Lighting: rock crystal, clear and blue glass. Maximum thickness of the drop: approx. Inoculation of 6 children.

Experiment No.	Exposure time			Child No.	Number of Scratches	Result of the Inoculation
	Rock crystal	clear Glass	blue glass			
1	200 Sec.			40	3	abortive stroke (1 pustule)
2	200 „			41	3	„ „ (1 P.)
3		5 min.		42	3	strongly A. (3 P.)
4		10 „		43	3	„ „ (3 P.)
5			5 Minutes	44	3	„ „ (3 P.)
6			10 „	45	3	„ „ (3 P.)

Trial series VIII: Vaccine from Calf 3. Vaccine Age: 9 days. Lighting: rock crystal, clear and blue glass. Maximum thickness of the drop: c. 0.4 mm. Inoculation of 10 children.

Forseg No.	Exposure time			Child No.	Number of Scratches	Result of the Inoculation
	Rock crystal	clear Glass	blue Glass			
1	200 Sec.			46	3	intel Estimate
2	200 „			47	3	no estimate
3		5 min.		48	3	strong A (3 Pustules)
4		5 „		49	3	„ „ (3 P.)
5		10 „		50	3	medium A. (3 P.)
6		10 „		51	3	„ „ (3 P.)
7			5 min.	52	3	strong A. (3 P.)
8			5 „	53	3	„ „ (3 P.)
9			10 „	54	3	medium A. (2 P.)
10			10 „	55	3	„ „ (2 P.)

Trial series IX. Vaccine from calf 3. Age of vaccine: 16 days. Lighting: rock crystal. Maximum thickness of the drop: c. 0.4 mm. Inoculation of 8 children.

Forseg No.	Lighting time	Child No.	Number of Scratches	Result of the Inoculation
1	125 Sec.	56	3	no estimate
2	125 „	57	3	no estimate
3	150 „	58	3	no estimate
4	150 „	59	3	no estimate
5	175 „	60	3	intel Estimate
6	175 „	61	3	no estimate
7	200 „	62	3	no estimate
8	200 „	63	3	no estimate

Experimental series X. Vaccine from calf 4. Age of vaccine: 18 days. Lighting: rock crystal, clear and blue glass. Maximum thickness of the drop: c. 0.4 mm. Inoculation of 10 children.

Experiment No.	Exposure time			Child No.	Number of Scratches	Result of the Inoculation
	Rock crystal	clear Glass	blue glass			
1	200 Sec.			64	3	no estimate
2	200 „			65	3	abortive A. (1 Pustule)
3		15 minutes		66	3	weak A. (3 P.)
4		15 „		67	3	„ „ (2 P.)
5		20 „		68	3	no estimate
6		20 „		69	3	abortivt A. (1 P.)
7			15 minutes	70	3	no estimate
8			15 „	71	3	no estimate
9			20 „	72	3	no estimate
10			20"	73	3	no estimate

Trial series XI. Vaccine from calf 5. Age of vaccine: 21 days. Lighting: rock crystal. Maximum thickness of the drop: c. 0.4 mm. Inoculation of 12 children.

Forseg No.	Lighting time	Child No.	Number of Scratches	Result of the Inoculation
1	35 Sec.	74	3	Medium Impact (2 Pustules)
2	50 „	75	3	(2 P.)
3	65 „	76	3	„ „ (3 P.)
4	80 „	77	3	„ „ (3 P.)
5	95 „	78	3	„ „ (3 P.)
6	110"	79	3	„ „ (2 P.)
7	125 „	80	3	„ „ (3 P.)
8	140 „	81	3	no estimate
9	155 „	82	3	weak A. (2 P.)
10	170 „	83	3	„ „ (3 P.)
11	185 „	84	3	„ „ (2 P.)
12	200 „	85	3	no estimate

Trial series XII. Vaccine from calf 10. Age of vaccine: 5 days. Lighting: rock crystal, clear and blue glass. Maximum thickness of the drop c. 0.5 mm. Inoculation of 10 children.

Experiment No.	Exposure time			Child No.	Number of Scratches	Result of the Inoculation
	Rock crystal	clear Glass	blue glass			
1	200 Sec.			86	3	weak impact (1 pustule)
2	200 „			87	3	medium A. (1 P.)
3		15 minutes		88	3	strong A. (3 P.)
4		15 „		89	3	„ „ (3 P.)
5		20 wo		90	3	medium A. (2 P.)
6		20 „		91	3	„ „ (1 P.)
7			15 Minutes	92	3	„ „ (3 P.)
8			15 „	93	3	„ „ (3 P.)
9			20"	94	3	„ „ (2 P.)
10			20 „	95	3	„ „ (2 P.)

Trial Series XIII. Vaccine from Calf 7. Vaccine Age: 26 days. Lighting: rock crystal, clear, blue and red glass. Maximum thickness of the drop: c. 0.5 mm. Inoculation of 8 children.

Experiment No.	Exposure time				Child No.	Number of Scratches	Result of the Inoculation
	Rock crystal	clear Glass	blue glass	Red Glass			
1	150 S.				96	3	weak Impact (3 P.)
2	200 „				97	3	abortivt A. (1 P.)
3		15 minutes			98	3	strong A. (3 P.)
4		20 „			99	3	medium A. (1 P.)
5			15 minutes		100	3	„ „ (2 P.)
6			20 „		101	3	„ „ (3 P.)
7				20 minutes	102	3	strong A. (3 P.)
8				30 „	103	3	„ „ (3 P.)

The experimental tables show: That vaccine, illuminated under the above conditions through rock crystal, is not noticeably affected by illumination times of less than 10 seconds.

When illuminated for periods of 10-100 seconds, there is a clear weakening and sometimes complete destruction.

By illumination for times of 100-200 seconds, very strong weakening or total destruction occurs. An illumination time of 200 seconds can be considered, under the above-mentioned conditions, as an illumination time that almost certainly leads to total abolition of the vaccine's ability to produce vaccine pustules.

For comparison, it should only be noted that a Prodigiosus culture, dried on a c. 0.3 mm thick agar layer and illuminated through it under exactly the same conditions, is killed by c. 40 seconds of light exposure.

The experiments also show that slight variations in the thickness of the illuminated layer are of great importance. In series of experiments I and II it is seen that the vaccine is destroyed after illumination for 100 seconds, while in series of experiments XII and XIII even 200 seconds of illumination does not lead to absolute destruction; exactly similar conditions are also found when we exclude certain parts of the spectrum (series of experiments XII and XIII).

From series of experiments IV, VII, VIII, X, XII and XIII it appears that in the destruction of the vaccine, as also in the destruction of the bacteria, it is mainly the ultraviolet rays that act.

5 min. Illumination through clear or blue glass, which retains a large part of the ultraviolet rays, thus has absolutely no detectable effect. Only 10 min. illumination through clear or blue glass produces weakening, and an illumination time of 15-20 min. is required to produce strong weakening or destruction.

The relationship is even more clear when the lighting is passed through dark red glass, which retains all chemical rays, since even 30 minutes of illumination does not affect the effectiveness of the vaccine to any detectable degree.

The slight variations that some experiments show are naturally explained by small differences in the experimental procedure, which are almost impossible to avoid, such as slight variations in brightness, drop thickness, etc.

It has not been possible to observe any difference in the effect of light on vaccines from different calves.

It has often been shown previously, ¹) that temperatures from 30°-40° have a weakening effect on smallpox vaccine and shorten the time it retains its ability to produce pustules; since it has now been shown here that strong light also has a very harmful effect, the same precautions must be observed when storing vaccines as with the known bacteria and their toxins, and therefore they must be stored in the cold and dark (possibly in red glass).

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1) Lemoine: Compt. clear de la Soc. they Biology. No. 12. p. 321.

ON THE PRODUCTION OF ARC LIGHT BY THE USE OF COOLED ELECTRODES.

OF

SOPHUS BANG.

After FINSEN demonstrated the usefulness of the "chemical" rays of light for therapeutic purposes, a number of attempts have been made, both here at home and abroad, to produce such rays in larger quantities or in a cheaper way than hitherto. These attempts have partly aimed at utilizing the ordinary carbon arc light in ways other than that used by FINSEN, and partly attempts have been made to use or produce new light sources with a greater wealth of chemical rays. It is only these latter efforts that I shall briefly mention here.

Since many metal spectra contain a great wealth of short-wavelength, i.e. strongly chemically active rays, it is reasonable that attention has been mainly directed to these. Thus FINSEN describes as early as 1896') an experiment which he carried out in this direction, following the suggestion of Prof. LA COUR, using calcium in such a way that a mixture of lime and graphite was placed in a borehole in the positive electrode, which as usual consisted of coal. The light thus produced proved to be very rich in chemically active rays, but the experimental results were not available at that time.

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1) "On the Use in Medicine of Concentrated Chemical Rays", p. 47.

for practical use, essentially because the glass collecting apparatus then used made the usefulness of the ultraviolet rays produced illusory. A year later I tried to use magnesium, partly as a metal, partly in various compounds; in this way too the richness of the light in ultraviolet rays can be increased; but its use has not been attempted in practice. A wick of zinc in coals has been used by MAGNUS MØLLER1) for his experiments on ultraviolet rays. Later, STREBEL) has suggested the use of aluminum oxide and silicate, as well as zirconium, in addition to the substances mentioned. Furthermore, he has used electrodes of metallic cadmium, aluminum and zinc, as he allowed high-voltage induction sparks to jump between poles of these metals; in this way he obtained a light that was extraordinarily rich in ultraviolet rays. An experiment with mercury as the positive pole and carbon as the negative, using direct current, was carried out in the winter of 1900-1901 at Finsen's Light Institute by KJELDSEN, using ARON'S and HEWITT'S mercury lamps as a starting point. By this method too, a light was obtained which was extraordinarily rich in ultraviolet rays.

A metal which, because of its great wealth of spectral lines, would seem particularly inviting to experiments is iron. This has been used in an electric lamp for therapeutic use by the Russian physician EWALD3), who in 1895 believed to have made the assumption that the workers in the ironworks in Kolomna (Moscow Governorate) who were employed in welding iron together with the help of electric current were protected from certain diseases, such as rheumatism. He therefore constructed a lamp, the positive pole of which consisted of cast iron, the negative of a carbon rod; a current of 2-300 amperes was used. The Ewald lamp was later used by KOSLOFFSKI in a private clinic in St. Petersburg. The patients had to be placed 11/2 meters away from the arc, as the radiation from the melting iron at a shorter distance was unbearable. The parts of the patient that were not to be treated were protected by screens. The sessions lasted for 2 minutes and were followed by skin erythema.

The use of metals as high-current electrodes is, however, associated with a number of practical difficulties, as the metal melts and spatters, so that the patient must be placed at a great distance from the light source, and the regulation of the lamp is thereby made difficult. In May 1901 I came up with the idea of cooling the electrodes with the help of water in order to avoid these disadvantages. I had acquired an X-ray lamp with a water-cooled anticathode for the use of the Light Institute; it was then natural to try water cooling also with ordinary direct-current electrodes. By forming an arc between two iron tubes through which water flowed, it turned out that a calmly burning arc light with the characteristics mentioned below was obtained.

Furthermore, a closer examination of the literature revealed that W. SIEMENS had already used a water-cooled metal electrode in an arc lamp in 1879. While the positive pole in this consisted of carbon, the negative pole was formed by a gilded metal capsule, the interior of which was cooled by a water stream. This ensured that the electrode was only slightly corroded, which was a necessary link in the regulation mechanism of the lamp in question; on the other hand, a change in the properties of the light was not intended by this cooling; as I will discuss in more detail below, it is also especially by cooling the positive electrode that the light changes character.

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1) MAGNUS MOLLER: Der Einfluss des Lichtes auf die Haut etc. Stuttgart 1900.

") Deutsche med. Wochenschrift, No. 5-6, 1901.

3) See KERNIG: Erfahrungen über die Einwirkungen intensiveven elektrischen Lichtes. Zeitschr. f. diet u. phys. Therapy. 1899, Vol. 2, p. 238.

The cooling of the electrodes can be done in several different ways. At lower currents (below 20 amps) I have so far generally preferred internal cooling, in such a way that the metal in question is shaped like a cap that can be screwed onto a double-walled tube with water circulation. At higher currents it is, at least for the positive pole, more practical to use external cooling, in such a way that the electrode is placed in a vessel with flowing water, so that only its tip protrudes above the water; in some cases it is advantageous to place the electrode tip right in the water crust or even a millimeter below it, which certainly changes the spectral character of the light, but does not prevent the arc formation. Under all circumstances the coolant must act on the electrode very close to the pole surface; for iron the distance must not be more than 3 mm; for metals with better thermal conductivity, e.g. Silver, the distance can be somewhat greater.

The most striking effect of the cooling is observed in the case of the positive electrode, as the "cratering", which is characteristic of this, is suppressed or at least reduced to a minimum. This is most clearly seen in the use of cooled carbon; as the thermal transition effect at the positive pole surface is suppressed, the carbon, instead of crater-shaped, becomes convex, but with small flat facets as an expression of the fact that there is still some local effect of the current at the place where the arc emanates from the pole. If cooled iron is used as the positive pole, the metal is consumed relatively slowly, as it disappears in the form of iron nitride; this decline is so slow, however, that an automatic regulation of the length of the arc has been dispensed with in the forms of lamps according to this principle that have been tried so far. If poles of less easily oxidizable metals, such as silver, are used, the pole is consumed only extremely slowly.

In connection with the fact that crater formation is so greatly reduced, it is stated that the heat radiation is relatively small. At currents of up to 10-12 amperes one can thus touch the electrode a few millimeters from the arc without feeling pain, and one can hold one's hand for a longer time at a distance of a few centimeters from the arc without discomfort. At a distance of 5 cm from an 8 ampere iron lamp, a blackened thermometer thus did not rise above 40° in repeated experiments. In an ordinary carbon arc light, the majority of both the luminous and the warming rays emanate from the glowing crater; this light is thus in reality for the most part an "incandescent light"; the light emanating from cooled metal electrodes, on the other hand, is predominantly a real arc light, since the electrodes only glow on the relatively small surfaces where the arc emanates from them. As a result, the character of the light is largely determined by the vapor spectrum of the electrode metal in question.

So far I have mostly investigated the light from cooled iron electrodes. Since the iron spectrum is so rich in ultraviolet lines, this circumstance determines both the properties of this light and its applicability. The properties that are of most interest when it comes to its applicability to skin disorders are its skin-irritating and bactericidal ability, as well as how deeply it is able to penetrate the tissues. As for the ability of iron light to induce a light reaction on the skin, this is extraordinarily great. A few minutes' stay at a distance of 1 meter from a 25 ampere iron lamp is able to induce a light rhythm in the facial skin. If the skin on the volar side of the forearm is exposed, for example, for 10 seconds of this light at a distance of 12 cm., an erythema arises, which is characterized as lyserythema in that it does not appear until a few hours after the irradiation, and in that it leaves pigmentation. The bactericidal properties of the light are related to this. While an ordinary

A carbon arc lamp of 30 amperes and 50 volts at the most favorable angle of radiation kills Staph. 1) pyog. aur. in 3-41/2 minutes in surface culture, a similar effect is achieved by a 25 ampere iron lamp in about 5 seconds (the time determined by illuminating through a suitable section in a rapidly rotating disk).

A peculiarity of ultraviolet rays is that they are absorbed so strongly by most substances, and in general the stronger the further out into the ultraviolet part of the spectrum they are. At wavelengths below λ = 2000 they are even absorbed strongly by water, and even by air. Glass is only fairly permeable to that part of the ultraviolet rays which lies closest to the violet part of the spectrum. In accordance with this, it has been shown that an ordinary object glass about 2 mm thick protected the skin completely against the influence of the iron light, which without the glass would have given a strong reaction with the formation of a bulla. The ultraviolet rays penetrate the skin even more difficultly. Thus STREBEL found that concentrated ultraviolet light could not pass a human ear compressed between quartz plates. In another experiment, a piece of skin, which had been prepared free of fat, was clamped between two quartz plates and "under exclusion of all color rays, illuminated with concentrated ultraviolet light originating from induction sparks between zinc and aluminum electrodes"; the irradiated object was 140 cm. from the spark; a faint but very distinct glow of light appeared on a fluorescence screen placed behind the skin. FREUND) investigated the absorption conditions in the epidermis, placing pieces of burn blisters, pemphigus blisters and Thiersch's epidermal patches in front of it.

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1) There is talk here about the "relative" murder limit. See the following treatise. *) Archiv f. Derm. u. Syph. Heft 1, 1901.

0.9 mm wide slit in a Rowland's grating spectroscope. As a light source he used the spark amplified by Leyden jars from a powerful Ruhmkorff inductor with electrodes of the EDER alloy (lead, zinc and cadmium) at a distance of 40 cm. from the slit. FREUND came to the same result for all 3 preparations examined; he found that, apart from the cadmium line λ = 3250 Å. E., ultraviolet light after an illumination time of 15 minutes did not pass through the pieces of epidermis in such quantity that they could affect the photographic plate; for the larger wave-widths, on the other hand, a certain quantity of the light passed through.

These experiments, which are interesting in themselves, do not provide any quantitative information, since one would have to know the energy distribution within the relevant spectrum, but one can probably draw the conclusion, which is also probable at first glance, that the ultraviolet rays that are closest to the violet rays penetrate the epidermis relatively better than those that are further out in the ultraviolet.

In order to obtain a preliminary idea of the distribution of the bactericidal rays in the spectrum of iron, I let light from a 25 ampere iron lamp pass through a spectral apparatus with lenses and prisms of quartz. As the spectrum thus formed lies in a line which forms a very acute angle with the rays emerging from the prism, I renounced examining the spectrum at the place where it was completely clean, but placed a surface culture of B. prodigiosus perpendicular to the direction of the rays at a suitable distance behind the prism, where the spectrum was sufficiently differentiated for my purpose. At this place the visible spectrum had an extension of 10 mm, while the ultraviolet, collected on uranium glass, had a length of c. 50 mm. It now appeared that with an illumination of 3-4 minutes the bacteria were killed in a

6-7mm wide stripe, the centre of which lay c. 15mm outside the outermost visible violet, while in the entire visible part of the spectrum and in the nearest 10mm of the ultraviolet no effect was visible. At an illumination time 3 times as long the bacteria were killed or weakened to an extent of c. 40mm in the ultraviolet spectrum, but even with this illumination they remained unaffected in the entire visible spectrum and the part of the ultraviolet closest to it. The rays which act most strongly on silver paper, as well as those which produce the strongest fluorescence in uranium glass, were found to be distributed in a similar manner. Presumably the agreement between these conditions is due to a corresponding distribution of the amount of energy in the short-wave part of the iron spectrum; however, this can only be determined with the help of bolometric investigations.

This much is already clear from these experiments, however, that those of the iron light rays which have the strongest effect on bacteria lie rather far out in the ultraviolet. This is in good agreement with the fact that the active parts of the iron light undergo a very strong absorption in the skin. Through a 1 mm thick, fat-free layer of skin (originating from the chest of a c. 12-year-old child), silver chloride paper is affected c. 3 times more slowly by the light from a 25 ampere iron lamp than it was at the same distance and under otherwise equal conditions by a 25 ampere carbon arc lamp. It is probably the visible rays also contained in the iron arc light that have caused the slight darkening of the paper which gradually occurred. Through a 0.1 mm thick layer of the same skin on the epidermis side (microtome section of frozen preparation), on the other hand, the silver paper was affected by the two types of light approximately equally quickly; this thin layer has evidently been able to penetrate some of the ultraviolet rays. That they are able to penetrate through

The epidermis also appears from the strong cardiac dilation they induce.

The properties of iron light, as far as we know them so far, are the following: Relatively little heat radiation; strong skin-irritating effect; strong bactericidal effect; very little penetration ability. The possibility of using this light clinically must be assumed to be linked to these properties. Where a superficial bactericidal and skin-irritating effect is desired, it must be able to find a field of action; it is not suitable for all deep-seated disorders, such as, for example, lupus vulgaris.

For preliminary clinical experiments I have made a small hand lamp for 8 to 10 amperes and 40 volts; it is intended to be applied in toto to the diseased area, so that the arc comes a couple of centimeters from the skin; it is provided with pressure quartz according to the Finsen pattern. The small thimble-shaped iron electrodes must be renewed when the lamp has burned for 3 to 4 hours, as they gradually oxidize and disappear as a smoke of iron oxide. One disadvantage is that this smoke regularly settles on the pressure quartz, which therefore has to be wiped off frequently. With this lamp, one can induce a typical light reaction with bulla formation after 3-5 minutes of illumination. Nothing definite can be said about the duration of possible therapeutic sessions; just as little can be stated as yet about specific indications for its use.

A direct comparison between the reactions produced by this small lamp and those produced by the use of Finsen's apparatus would be misleading; for as the light from the latter contains a large quantity of the rays which penetrate into the depth, the difference in the reactions produced by the use of the two kinds of apparatus is not merely quantitative, but qualitative. The hand lamp should probably considered from the point of view that where an intense but superficial effect is desired, it provides such a means in a considerably cheaper way than has hitherto been possible; where a deep effect is necessary, it should not be used at all.

ON THE EFFECTS OF LIGHT ON MICROBES.

II. AN IMPROVED METHOD OF INVESTIGATION.

OF

SOPHUS BANG.

In a previous work[1]) I have drawn attention to how necessary it is in studies of the bactericidal effect of light to take into account that the nutrient in which the bacteria are located under the illumination absorbs a substantial part of the light used. The BUCHNER method, improved by FINSEN, is the most accurate of those used so far. However, when it comes to determining the killing time of the bacteria accurately, the objection can be made to this method that it illuminates the bacteria distributed in an agar layer, namely as a spread culture. Under these conditions, the bacteria lying in the depths of the agar are not reached by the light until it has been filtered through a more or less thick layer of the agar, which, like most other nutrient media, due to its yellowish color and other spectroscopic properties, absorbs to a particular extent the short-wave rays, that is, precisely those that are most effective against microbes. Small changes in the thickness, color and other properties of the nutrient can therefore have an influence on the time that the light must act to kill the bacteria. For

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[1]) S. BANG: On the Effects of Light on Microbes. I. Messages from the Finsen Medical Light Institute II. Copenhagen. 1899.

To reduce this unpredictable light absorption as much as possible, I used "hanging drops" of a maximum thickness of 0.05-0.15 mm in the work mentioned. The light absorption of the nutrient was not completely eliminated, but was nevertheless reduced to a relatively small value, and a uniform effect of the surrounding air was also possible. Since a number of other physical factors were also taken into account, it was possible to obtain fairly constant experimental results, which was difficult with the older methods. It also turned out that the bacteria were killed in a much shorter time than one would have expected from the previous results. This is easily understandable; the microbes lying in the depth of a light-absorbing agar layer can withstand a longer period of illumination than those lying closest to the surface.

Dr. V. BIE has gone a step further in the direction of eliminating the light absorption of the nutrient by using surface cultures on agar, prepared in such a way that a few drops of the bacterial culture in question are spread on the nutrient substrate solidified in a Petri dish; using a desiccator with calcium chloride and air dilution, the culture liquid is dried as an even layer; when the surface thus prepared is now exposed to the light, this has no extraneous substances of any importance to pass through before it hits the bodies of the bacteria.

Since this procedure is, however, somewhat cumbersome, and since such an energetic drying process is in any case unlikely to have an effect on the vitality of several bacteria, I simplified the method in such a way that, with the aid of a fine cotton swab (an iron wire wrapped in fine hydrophilic cotton, sterilized in a test tube), I spread the bacterial culture as uniformly as possible on the agar plate, which is then left to dry spontaneously. My assistant, Dr. JANSEN, has recently used, instead of the cotton swab,

used a platinum eyelet; this achieves, on the one hand, that one is somewhat aware of how large a quantity of the culture is sown, and on the other hand, the surface dries even more quickly in this way by itself, already in 2-3 minutes. By "drying" here is understood only that there is no free, mobile liquid on the surface; the agar itself retains its moist consistency and is stored during and after the experiment in an atmosphere saturated with moisture (see below). One cannot completely deny the possibility that this method can have any influence on the resistance of the bacteria, especially when it comes to species that are particularly sensitive to drying out. But as long as one does not do experiments with such species, and as long as one is only talking about similar experiments with one and the same bacterial species, this circumstance will not play any demonstrable role.

That the bacteria really remain on the surface of the agar without penetrating into it can be confirmed, on the one hand, when they have later grown so far that the colonies can be seen with the naked eye, which, at least in the case of the bacteria examined so far, remain completely superficial; on the other hand, in the case of the tubercle bacillus, by hardening a plate so inoculated and making vertical microtome sections through it, I have directly convinced myself that the bacilli lay in a thin, even layer on the surface, without it being possible to see anywhere that a bacillus had penetrated through the surface of the agar layer.

The illumination of the surface cultures can be carried out in various ways; it is practical, especially time-saving, to use stepwise illumination. This method was used in 1893 by WARD ¹), who illuminated spread cultures in

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¹) MARSHALL WARD: Further experiments on the action af light on Bacillus anthracis and on the Bacteria of the Thames. Proc. of the Royal Soc. of London, Vol. LVI, 1894.

Agar through square or circular "windows", which were covered one by one under the illumination. A similar method was used by FINSEN, independently of WARD, in his first experiments on the bactericidal effects of light[1]), in that, in addition to the method published at that time, he also used the following, which he himself describes as follows: "Plate cultures in a Nielsen bottle were exposed to the light in such a way that after 1 minute a small field of the plate culture was covered with a piece of paper, after 2 minutes a new field was covered, after 3 minutes a third field, etc. The pieces of paper, which were glued with fish glue, were black on the side facing the bottle, to prevent the light from penetrating, and white on the side facing the light, to prevent the heat from acting. Numbers were written on the white side to indicate the time the underlying field had been exposed to the light. When the bacteria had grown out and the pieces of paper were removed, it showed A mosaic was formed, produced by the different effects of the different fields, and one could now read how long the light had taken to kill the bacteria. Later the method was modified in such a way that the entire surface of the bottle was covered with the same kind of paper, in which a number of round holes had been cut out; after the bottle had been exposed to the light, the individual holes were now covered in sequence and at certain intervals; in this way the effect of the light appeared sharper, as each field was now surrounded by a culture completely unaffected by the light, while the surroundings thus simultaneously served as a control. These methods were used for unconcentrated light."

I have combined the use of Step Lighting with

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[1]) FINSEN: On the Use in Medicine of Concentrated Chemical Light Rays. 1896. P. 28-32.

The use of the surface cultures mentioned in this way is that I let a flat "shadow generator" advance step by step past the culture at certain intervals. Instead of, as is usually the case, illuminating one preparation for, say, 1 minute, another preparation for 2 minutes, etc., I illuminate a larger area of the surface culture for 1 minute, then let the shadow generator advance one step, whereby a corresponding strip of the culture is protected from the light; after a minute has elapsed, it is advanced a new step, so that now a total of two strips A B G lie in darkness, etc. While the first method for finding the effect of 1 to 10 minutes of illumination d j D requires 1 + M P 2+3...+10 min. = 55 min., in addition to the preparations for the individual experiments, the same series of experiments in the other only 10 minutes in total, and only preparations as for 1 experiment. In addition, it is of course easier to keep the light source constant for 10 minutes than for 55.

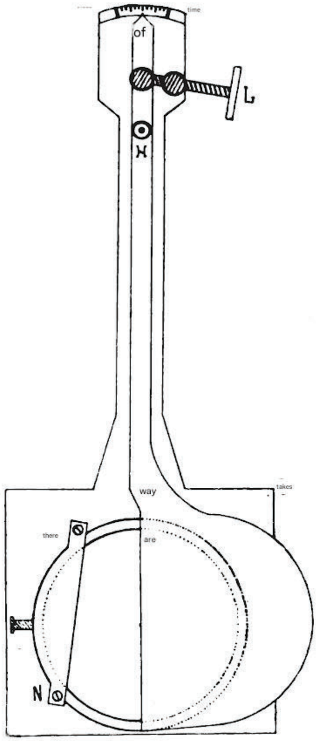

Fig. 1.

The accompanying schematic drawing shows the arrangement of the apparatus in which the illumination takes place. The brass plate ABCDEF has a circular cutout MNOQP, which is closed with a plane-parallel quartz disc, behind which the surface culture is

The shadow generator OKJ consists of a thin brass plate with a long stem JG, which can be turned around the pin H by means of the screw L. This moves the shadow generator so that its edge OP moves to the right or to the left immediately in front of the quartz disc R. The amount of the displacement is read by means of the pointer G. When the shadow generator is moved as far to the left as it can go, the edge OP touches the small shades a part of the quartz disc; the corresponding part of the culture thus serves for control. When the shadow generator is moved as far to the right as possible, it shades another part of the quartz disc at Q, also for control. At Uses a tube is used through which gases, the effect of which is to be investigated, can be introduced to the surface of the culture (a similar one is found next to Q).

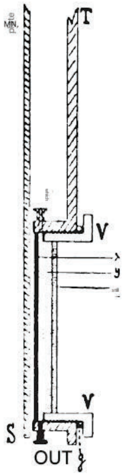

Fig. 2.

Fig. 2 shows a vertical sagittal section through the lower part of the apparatus. TT is the brass plate on which the whole is mounted. SS is the shadow generator. At X is the quartz plate. VV is a circular dish in which the agar plate (y) sown with the surface culture rests on a glass plate. At UU are the tubes through which various types of gas can be supplied. The culture dish VV is screwed into the apparatus and is provided with a rubber ring (g) to make it airtight and watertight.

In general, the whole apparatus is placed in a "photo-kteinometer" of the construction described in my work above. As I have made a slight change to this for a special purpose, I give a sketch of it in Fig. 3, referring to the details in the description given. The tin box ABCDE is placed in front of

The light source L is so placed that the light rays strike its front surface at a right angle (when it is a common electric arc lamp, the box is best placed at an angle of 50° to the axis of the coals). The box is normally filled with boiled distilled water, which is kept at a constant temperature by means of the lead tubes RR through which the water flows and the stirrer P. The shadow-giving apparatus HHH is placed in the scenes J.J. The light enters the box through the quartz window MN, passes the plane-parallel liquid layer between this and HH, and finally reaches the surface culture through the quartz window X (see also Fig. 2).

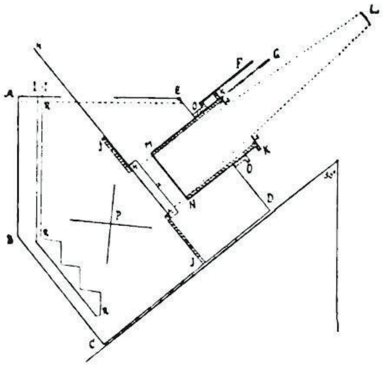

Fig. 3.

The only obstacle that the light ray encounters on its way from the light source to the bacteria is, apart from the air, the two flat quartz plates and the flat liquid layer lying between them. In order to be able to vary its thickness in a certain way, the front quartz pane, MN, is placed at the end of a tube KNMK, which can be screwed in and out of the ring OO. The thickness of the liquid layer can be read on the scale F. At ss, a diaphragm can be inserted if necessary to prevent the reflection of light from the sides of the tube, which, like the rest, Everything inside the box is matte black. The lid is used to open and close the light.

In order to be able to compare different research results with a common standard, I have provisionally and purely arbitrarily determined the following experimental conditions as "normal experiments".

An electric direct current arc lamp of 30 Amperes and 50 Volts is used as a light source; by means of insertable incandescent lamps the current intensity is regulated with an accuracy of at least 0.1 Amperes. The positive carbon has a diameter of 24 mm., the negative of 15 mm. (One of the difficulties in reproducing the same brightness at all times by means of such a lamp lies in the fact that the nature of the carbon can vary. By means of projection images of the arc in different directions one ensures that the crater burns with a regular shape. The "photoctinometer" is set up so that the rays which strike the centre of the quartz window form an angle of 50° with the axis of the carbon. The distance between the nearest point of the crater and the surface culture is 60 cm., which corresponds to a distance of 60 cm. without a water layer, since this is 2 cm. thick [1]).

As a test bacterium I have so far used Staphylococcus pyogenes aureus in a 20-hour broth culture, grown at 37°. It is filtered through ordinary, sterile filter paper and then diluted with 2 parts sterile broth. Of the broth thus diluted, which to the naked eye has a cloudy appearance, a suitable amount is transferred in the manner described with a cotton swab or platinum eyelet to the surface of a sterile agar plate, which has preferably been embedded in the culture dish a couple of hours beforehand. As soon as the liquid layer has dried sufficiently, the dish is screwed into the shadow-giving apparatus, and this is placed in the "photoctinometer", which should preferably contain liquid of at least 28°, thereby most certainly preventing fogging on the quartz window. After the gradual illumination has taken place, the removed culture dish is placed in a Petri dish lined with moist filter paper, which is placed in the thermostat, preferably at c. 34°, at which temperature it is easiest to avoid so much condensation forming that it can drip from the lid of the Petri dish onto the surface culture.

After 24 hours of standing, the culture has an appearance like Example Fig. 4, which is reproduced from a photograph.

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[1] See the cited work, p. 15.

To the right and left are two crescent-shaped areas with strong, confluent bacterial growth; these are the unilluminated control areas; between these areas 10 stripes have received 1 to 10 minutes of illumination respectively. In order to be able to read the location of these stripes conveniently, a glass plate on which are drawn sub-lines, corresponding to the individual displacements of the shader, is held in front of the (surface culture). The stripe furthest to the left has received 1 minute of illumination. A weak light effect is already evident here in that the stripe can be seen at all distinguished from its surroundings; an even slightly stronger effect is seen in the next strip, which has received 2 minutes. In the 3rd strip (3 minutes of light) there is a noticeable thinning, and in the 4th strip (4 minutes) the number of colonies is so small that one can count the individual colonies (c. 50). In the 6th strip there are 11 colonies, in the 7th 5, in the 8th 4, in the 9th 4 and in the last strip, which has been illuminated for 10 minutes, there is only 1 colony. So we have not yet reached the absolute killing limit after 10 minutes of illumination (by which I understand the point at which even the most resistant individuals are killed; this is seen from another experiment (Fig. 5).

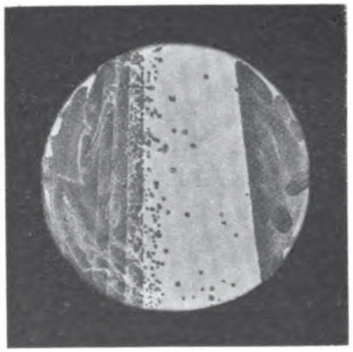
Fig 4.

Here 12 stripes are illuminated in such a way that the one furthest to the left has had 6 minutes, the next 7, and so on until the 12th stripe, which has been illuminated for 17 minutes. The number of colonies in the individual stripes is respectively c. 10, 11, 2, 6, 4, 2, 3, 2, 0, 0, 0, 0. So, from the 14th minute onwards the absolute killing limit seems to have been reached. However, it is only quite approximately and with reservations that one can after such a Experiments can set the absolute killing limit at 14 minutes; for where this limit will lie obviously depends, among other things, on the number of bacteria sown per square unit. An apparently sharper limit is seen after 4 minutes of illumination (Fig. 4), where the number of colonies has become "countable", while the colonies in the preceding stripes are so numerous that they flow together. The location of this limit, which I will call "the relative killing limit", for the sake of brevity, also appears to depend on how many bacterial individuals have been sown per square unit of the agar surface. This can be shown by making the following search with different dilutions of the same culture, such as in the following series of experiments:

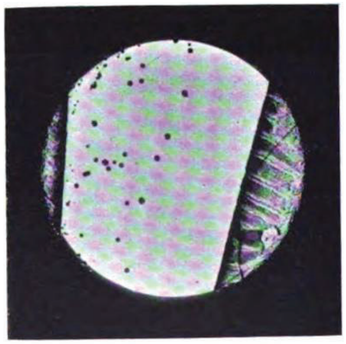

Fig. 5.

			Tribal culture.	Dilution 1:3	Dilution 1:9	Dilution 1:18	Dilution 1:36
Lighting 3		My.	Weak Thinning	Weak Thinning Strong	Strong Thinning	c. 50 Col.	Strong Thinning c.
—	$3^1/_2$	-			c. 50Ko l.	22 -	50 Col.
			Strong Thinning	Thinning			
—	4	-	c. 50 Col.	c. 50 Col.	10 -	8 -	5 -
—	5	-	30 -	12 -	1 -	0 -	4 -
—	6	-	16 -	4 -	0 -	2 -	3 -
—	8	-	2 -	4 -	2 -	3 -	0 -
—	10	-	2 -	1 -	0 -	1 -	0 -

We therefore find no sharp killing limit for cultures of Staph. pyog. aur. The conditions here are quite similar to those which I have previously demonstrated for B. prodigiosus by means of the drop method, namely an increasing dilution with increasing light exposure. In these, as well as in a whole series of bacteria examined later, it has been consistently shown within certain limits that the longer the exposure to light, the lower the percentage of bacteria that is able to resist it. But it seems that this "dilution curve" has a different location and perhaps also a different form in the different species of bacteria, as an expression of the different way in which the unequal resistance of the individuals to light is expressed in the different species. I shall not, however, go into these conditions in more detail here, as they are currently being made the subject of special investigations.

On this occasion I only wish to illustrate the applicability of the method for "biological light measurement", that is, for determining the relative ratio between the richness of different light sources in bactericidal rays or light-permeability of filters for such. It has now been shown that for many practical studies of this kind one can use the location of the mentioned "relative killing limit", i.e. the place in the culture where the bacterial colonies from having been "innumerable" have become "countable" (c. 50-100). In 11 experiments, carried out with Staph. pyog. aur. in the described "normal" method, this limit was at 4.31/2 4.31/2, 3.4, 31/2, 41/2, 41/2 minutes, on average, i.e. about

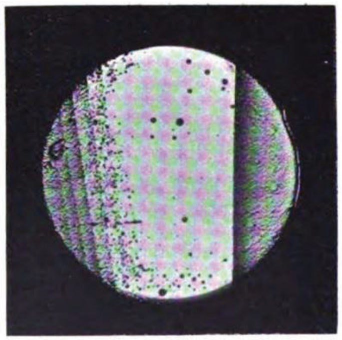

Fig. 6.

trained at 33/4 minutes, with a margin of 3/4 minutes or 20% on either side. This applies when the experiments are made at different times; the lack of more exact agreement is due to the difficulty of obtaining uniform cultures. Much greater accuracy can, as I shall return to below, be obtained by comparative experiments carried out simultaneously or immediately after each other with one and the same bacterial culture.

However, the aforementioned accuracy of c. 20% is already sufficient for many practical investigations, as it is often enough to obtain approximate values, among other things because the different light sources that are to be compared are often so different that they are difficult to compare.

equally different from each other in brightness. I will mention a couple of examples of this. While a 30 ampere carbon arc lamp at a distance of 60 cm., as mentioned, shows "relative killing" on average at 33/4 minutes, the same effect was obtained at the same distance in about 4 seconds by means of an arc lamp with the same current strength, but whose positive pole consisted of a water-cooled iron rod. Direct sunlight took on August 21, 1901, at 11-2 (in Copenhagen) over an hour to produce the same effect (see Fig. 6, where the shader has been moved every quarter of an hour, so that the shortest illumination is 1/4 hour, the longest 3 hours).

As an example of the greater accuracy when comparative experiments are made with one and the same bacterial culture, I can mention that in repeated experiments (a total of 6) it has still been possible to demonstrate the difference in the absorption that the light undergoes, whether it passes, for example, 2 cm. of distilled water or an equally thick layer of ordinary water. While the relative killing limit, when the tube KMNK (Fig. 3) was screwed in so far that the light only had 1/2 cm. of distilled water to pass, was found at 31/9 minutes, it was, on the other hand, when the apparatus was filled with ordinary water, at 5 minutes. When the thickness of the water layer was 3 cm., distilled water was obtained.

	12 cm. distilled water	1/2 cm. plain water	3 cm. distilled water	3 cm. regular. Water
Lighting 3 Min.	strong Ext.	weak Ext.	weak Ext.	Hint
— $3^{1}/_{2}$ -	c. 50 Colon.	Thinning	Thinning	weak Ext.
— 4 -	15 —	strong Ext.	strong Ext.	Thinning
— $4^{1}/_{2}$ -	8 —	strong Ext.	c. 50 Col.	strong Ext.
— 5 -	7 —	c. 50 Col.	28 -	strong Ext.
— $5^{1}/_{2}$ -	0 —	30 -	10 -	c. 50 Col.
— 6 -	0 —	20 -	3 -	?

a Killing limit at 41/2 Min., for ordinary water at 51/8 Min.

From this we can see how important it can be to use the clearest possible water in the light filters of the therapeutic apparatus. And it will not be surprising that the light absorption that takes place in the commonly used nutrient substrates can reach a very considerable size. To investigate this further, I filled the "photoctinometer" with broth instead of distilled water. I used a light calf broth, which in color corresponded quite closely to a 1/400 solution of potassium dichromate; through a 2 cm. layer of this broth a surface culture was illuminated for 2 to 24 minutes, without any noticeable effect of the light; the experiment was repeated after 1 part of the broth had been diluted with 24 parts of distilled water; again a completely negative result after 24 minutes of illumination. Only when the broth was diluted with 48 parts of water, and the thickness of the layer was reduced to 1 cm., was it possible to obtain the relative killing limit after an illumination time of 60 minutes. The layer of diluted broth used would correspond approximately to a 1/2 thick layer of undiluted broth. The light used in the experiment therefore took 1 hour to exert the same bactericidal effect through this layer as it takes 3-41/2 minutes when it has 2 cm. of distilled water to pass through. We have here direct proof of the necessity of eliminating the light absorption of the nutrient substrates when one wants to investigate the effect of light on bacteria. etc.

Finally, I thank Dr. JANSEN for his valuable and tireless help in working out the details of the method.

TREATMENT OF SMALL POTASSIUM WITH THE EXCLUSION OF THE CHEMICAL RAYS OF DAYLIGHT.

OF

NIELS R. FINSEN.

Two colleagues, Mr. District Physician KREBS in Vordingborg and Mr. City Physician LUNDDAHL in Aarhus, have been so kind, at my request, to give me information about and permission to publish some cases of smallpox that they have treated in red light, for which I hereby offer them my best thanks. Dr. KREBS has 1 case, Dr. LUNDDAHL 9, somewhat mild. These cases would not mean much if they stood alone; but they have significance when they are added to the series of cases that are already available. Smallpox is now in any case such a rare disease in this country that one must be grateful for every new case about the effect of its treatment with the exclusion of the chemical rays of light.

District physician KREBS writes the following:

"On September 4, 1900, I had a smallpox patient under treatment; the smallpox had broken out on the 3rd. It was not until the 6th that Pt. was interned in a Döcker felt tent with red cotton cloth for the windows."

The case was of a serious nature, and the smallpox would certainly have become confluent, not only on the face, but also on its places on the body, if the patient had not been treated.

in red light. (He had 108 cups on his right hand alone, and here there are almost none in comparison with the rest of his body," said Pt.).

Many papules had become vesicles and some pustules, especially on the face when he was exposed to red light. An hour later the itching, stinging, heat and tension of the skin which accompany smallpox began to subside, and the next day the swelling had noticeably diminished. Neither vesicles nor pustules developed further; there was neither suppuration nor suppurative fever.

In place of the ugly brown and gray spots known from earlier times, there remained a number of lively, pinkish-red papules which could be pressed away with the finger, but which, as soon as the pressure ceased, filled with blood again due to abundant vascularization. A number of punctate depressions remained on the face, but no real smallpox scars.

"To me, who has seen cases of smallpox in large numbers several times in the past, the mild course during the treatment in red light must have seemed quite astonishing, and the treatment should probably be carried out consistently in the future, whenever the disease should appear, since in my opinion it must be considered to be of great and far-reaching importance."

Mr. City Physician LUNDDAHL writes to me on 7/11 1901:

"By appointment I hereby send a brief summary of my smallpox cases with special regard to their treatment in red light and their presumed results."

No. 1. 5-year-old girl. Vaccinated with good response during the incubation period. Scattered varicella-like eruption. First observed later in the disease, when scattered infiltrations with tough, resistant crusts had formed, which were slow to fall off and left scars, which were, however, quite superficial. Not treated with red light.

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No. 2. 7-year-old boy, not vaccinated. Severe initial symptoms. Ill on April 15, 1901. Papular exanthem appeared on April 16-17. Admitted to hospital on the 17th. 3-layer red shirting over the windows. The room became very dark. The hallway was opened to daylight for a very short time. The exanthem spread and became vesicular. At the same time the temperature fell, but the severe deterioration of the general condition persisted. On the 22nd-23rd the suppuration began, the temperature rose slightly in the morning (c. 38); in the evening it had been 38 to 38.5. Confluence of the exanthem, continuous crusts over large areas with underlying "fluttering" pus. Decomposition with a disgusting stench. Around the 24th. Age approaching 40. Died on the 26th of April.

This case had manifested itself from its very beginning as a particularly violent one. Although he was placed in the "red room" early in the illness, even with very little light, the case nevertheless proceeded apparently unaffected by this. The only effect could perhaps be that a high fever did not occur at the beginning of the suppuration stage. It only came when the pus began to decompose.

No. 3. 4-year-old girl, sister of the previous one, vaccinated immediately at the outbreak of the disease, no attack. Exanthema began weakly on the 18th, clearly advanced on the 19th of April. Admitted on the 19th in the morning in the same room as the brother. The general condition was very poor, although without high fever, the first few days. The exanthema spread everywhere, but did not become confluent; on the 23rd-24th the contents of the vesicles began to turn yellow, with a slight increase in temperature (morning 38.4), but the next day the general condition improved quite suddenly. On the 25th-26th the pustules began to dry into looser, less cohesive crusts, which fell off quite quickly, leaving large, red, round spots, especially on the uninjured covered skin areas, which lasted a long time; some scars also formed on the face, although rather small and superficial. On May 4th, red light was discontinued. She was given baths from the beginning of the encrustation period. The exanthema itched only very slightly.

No. 4. The mother of the children had so slight an exanthem that it was worth treating her in a red light. The attack was so slight and not even considered to be a nuisance.

No. 5. Her infant child, 3 weeks old, was attacked together with the mother (vaccinated shortly before the outbreak, no attack. At first only very sparsely scattered exanthema, a few vesicles here and there and apparently well-being. Only about 8 days into the illness did vesicles appear to a greater extent, become confluent, and finally almost the entire surface of the body was a suppurating surface. The child died on the 28th. When the exanthema broke out more strongly, red curtains had been hung around the cradle, but in the first days, when the eruption was so very slight, nothing had happened in that direction, which must have turned out to be a mistake.

No. 6. A washerwoman in her fifties. Infected from the aforementioned family. Ill on 25/4. On the morning of 26/4, widespread papular measles-like exanthem, Tp. c. 41, general condition greatly affected. Admitted the same day, morning-afternoon, placed first in a room with red window curtains, later in a room with red panes. That evening, Tp. 38.8, became normal in the next couple of days. On the widespread initial exanthem, quite a few scattered vesicles formed, but the majority of the exanthem disappeared without a trace. The general condition improved very quickly. The vesicles quickly dried up into small, tough crusts, leaving some minor infiltrations and, on the palm of the hand, a few small blood oozes under the epidermis. Overall, the exanthem had a quite abortive course. She remained in the red room for approx.

12 days. Through the red windows, which were used in the future, considerably more light came into the room, the patients could see, read and work and were generally comfortable in this light, there was never any particularly strong desire to get out of there. I cannot say whether the greater amount of light that came in, and this was also in the very bright spring months, played a part in the fact that — none of the patients, not even the most easily affected, completely avoided scars, which were not very deep and would probably be almost completely erased in the future. (The scars only appeared on the uncovered parts of the skin). But even if that were the case, most patients would perhaps prefer such a brighter "red room" to a dark one, even with the risk of getting some small scars on their faces. I do not believe that the patients would have sneaked out to let in daylight. In addition, they — were too interested in the Treatment and afraid of violating it.

No. 7. 5-year-old girl, vaccinated with good response during the incubation period. Ill on 2/5, vesiculos eruption on 3/4, on 4/5 very widespread vesiculous exanthem with yellow pus-like content. General condition very little affected, Tp. from hospital admission on 4/5 not over 38. Desiccation quickly set in in the form of light, loose crusts and scales. Almost no itching. Laid in red light from 4/5 - 18/5. On discharge in mid-June large, red spots all over the body. Small scars scattered on the face.

No. 8. 65-year-old woman, not vaccinated since childhood. Ill on 4/5. The next day widespread vesicular eruption, which increased in the following days, became confluent on the inside of the thighs and was very tight all over. Also strong mucosal eruption. Tp., which was 39.6 on admission, fell rapidly, was already 38 the next evening on 5/5, remained low the next days, but went up to 38 on the 8th in the evening and on the 9th in the morning, when in the severe and widespread eruption

The contents of the vesicles became purulent. Desiccation began early, on the face in the form of tough, dark crusts, on other parts of the body as scales and small yellowish crusts, mainly just peeling. The mucous membrane eruption subsided very abruptly. The general condition after the first couple of days was good. I — lay in red light for a good 14 days. Slight scarring on the face as in the previous cases.

No. 9. A child died of purpura variolosa within an hour of admission to the hospital.

No. 10 and 11. Young women, not vaccinated since childhood, with mild variolae discretae on the transition to varioloids. Each of them was observed for about 4 days at home. Treated with red light from admission for about 10-12 days, the vesicles dried up into small crusts or disappeared completely, leaving small red spots. However, a few of them on the face left scars similar to those previously described.

No. 12. Young woman (in her 30s), ill on May 15, papular eruption on May 17, vesicular eruption beginning on May 18. High fever and severe initial symptoms; the exanthema became widespread. Severe mucosal eruption. Admitted to — hospital on the morning of the 1st. Her general condition, somewhat affected in the first few days (she was also in the 5th month of pregnancy), improved considerably from May 21. At this time some of the vesicles began to have yellow contents (no particular increase in Tp. corresponding to this stage). The course of the eruption was generally as follows: In the forehead the vesicles dried into small crusts, in the rest of the face the contents were resorbed and papular infiltrations remained. On the body and especially on the lower extremities, the vesicles were filled with yellow contents, which, however, were also resorbed, in some places small yellowish loose crusts formed, in most places only scales. The mucous membrane eruption subsided quite abruptly. She was in red for a good 14 days.

Room. On discharge from the hospital on June 28, the face was densely covered with red spots, and especially on the forehead numerous scars formed, closer together but not deeper or, in each case, more widespread than in the previous patients.

Nos. 13, 14, 15, two young women and a small child, all from the country, came in so late and with such mild cases that there was no question of red-light treatment in their case.

With regard to the effect of the red-light treatment, one can perhaps say that it had no particular significance for No. 2, and that No. 3 progressed well may be attributed to the treatment. Whether No. 5 had been saved by treatment carried out from the beginning is perhaps doubtful in view of his young age. No. 6, who began violently and progressed abortively, and No. 8, who despite a rather violent beginning and extremely widespread exanthem, nevertheless took a quite benign course, as well as No. 12, who also showed a very widespread eruption, and in whom the condition was quite precarious in the first few days, may also be counted among the good results of the treatment. Whether it has had any significant significance for the initially mild cases of Nos. 5, 10 and 11 is probably uncertain."

When I had received these medical histories and it seemed to me that the results, both with regard to the entire course and with regard to the scarring, were less good than they usually are with treatment in red light, and since it is mentioned in Journal No. 2 that daylight was let in at the entrance for a very short period of time, it occurred to me that the less favorable results were perhaps due to such short-term access to daylight. I therefore wrote to Mr. Stadsläge Lund-dahl and asked for information on this question, which, of course, is of great interest, since we do not really know for sure how much light or how long exposure to daylight is sufficient to cause damage. Furthermore, I asked how the patients' skin was now, after half a year; experience shows that even if patients have small scars when they are discharged after red-light treatment, these disappear after a certain time, since they are so superficial.

Mr. City Physician Lunddahl showed me the kindness to immediately examine the patients again, which revealed that "only Patient No. 3 could be described as to some extent co-parous".

With regard to Daylight, I received the following information: "Daylight was let in during the hallway for all patients. For the first two, the curtains were lifted a little to the side. For the others, the windows were opened a crack. There was never any question of longer exposure to daylight; in half a minute you can see a lot, and I don't think it was longer in the hallway. On the other hand, it may have been a couple or more times a day from time to time. Under the circumstances, there could be no specific hallway time, so the patients could not be demonstrated at specific times, but the colleagues here could go in when they wanted to and see the patients. This meant that they were exposed to daylight more often, but for a shorter time at a time."

This information is of great interest and gives these case histories an increased significance, as we seem to have here a clear confirmation that even very short exposures to daylight have a harmful effect and should be avoided. On the other hand, the use of candles or an ordinary kerosene lamp in the hallway will not cause any inconvenience to the patients. It is even very possible that one

Candles or kerosene lamps could be kept burning in the sickrooms all day long, without harm to the patients, because there are so few chemical rays in such light. But the opportunity to experiment with this is rare. A series of experiments by which one could investigate and determine what artificial light and how strong artificial light smallpox patients could tolerate without suppuration would be of great practical importance, partly because some people seem to have an aversion to red light, and partly because the treatment could then be carried out everywhere, even where there were no red panes or red carpets to hang over the windows.

I would like to point out here that now, after the method has stood the test everywhere, it should be considered the doctor's first duty as soon as he has made the diagnosis of smallpox to see to it that the windows of the hospital room are in some way tightly covered and that a light is turned on. When the treatment can be so easily arranged, it is not really advisable to leave the patients exposed to daylight until they can get into the red light of the hospital; time is precious, and the sooner the treatment is begun, the more chance there is for the patients to avoid suppuration and its consequences.

TREATMENT OF THE ROSE WITH THE EXCLUSION OF THE CHEMICAL RAYS OF DAYLIGHT. BY NIELS R. FINSEN.

When I published my treatment of smallpox with the exclusion of the chemical rays of daylight eight years ago, I emphasized that this was not a special treatment for smallpox, but a new therapeutic principle which could reasonably be of importance in other exanthematic diseases and skin diseases; I drew attention to how interesting it would be to find out whether the chemical rays had any influence on these diseases or not, and emphasized how easy it would be and also quite harmless to make such experiments, e.g. with measles, scarlet fever and rubella. I made some efforts at that time to get such experiments started, but as I encountered some difficulties and was also ill and not very capable of work myself, it came to nothing, and I therefore limited myself partly to some statistical studies to see if there was a difference in the course of the diseases mentioned in summer and in winter, and partly to suggest how to carry out trials and control experiments.

Some time later I received from Mr. Corps Physician Dr. med. KIER, who was then Chief Physician at the Garrison Hospital, a gracious offer that I might be allowed to make experiments.

with this treatment in his department. As there were just a few cases of rose, we started with this disease. At my request, Dr. KIER took over the entire treatment, I was only helpful with the installation. In total, only 7 cases of rose were treated, as Corps Doctor KIER's term of service expired just in those days, and the new chief physician did not appreciate continuing the experiments. As I thought the cases were too few and too poorly defined to allow any conclusion to be drawn from them, either positive or negative, they were not published.

Now, however, a report has recently appeared from Dr. KRUCKENBERG, chief physician at the municipal hospital in Liegnitz, about a number of cases of the rose, treated in red light. This has given our 7 cases some value as a supplement to Dr. KRUCKENBERG'S. I have now obtained permission from Dr. KIER and the present chief of the garrison hospital, staff physician BJERRING, to publish them and hereby offer them both my best thanks.

To avoid misunderstanding, I would add that it is not my intention in this publication to attempt to take the priority from Dr. KRUCKENBERG; but since these 7 case histories did not give such favorable results as Dr. KRUCKENBERG has obtained, it seems to me that there is special reason for, and that I have a certain obligation to, publish them now.

I will first present a review of Dr. KRUCKENBERG'S thesis, which is due to Dr. JANSEN, and then Dr. KIER'S medical histories.

HERMANN KRUCKENBERG: Traitement de l'erysipèle dans la "chambre rouge".

Revue internationale de thérapie physique. 1 February 1902.

The author, who is the head of the municipal hospital in Liegnitz, has treated a number of cases of erysipelas in red during 1900.

Room, prompted by an article by Dr. Bie in "Therapeut. Monatsh.", where a comprehensive presentation of the entire Finsens phototherapy is given, both the "negative" and the "positive".

Right at the beginning of the article, Dr. K. says that he has come to the conclusion that this treatment has a very favorable influence on the disease, and adds in a footnote that Dr. Roemer at the same hospital has also successfully adopted the method. But on the other hand, he himself emphasizes how difficult it is to say anything certain after a single, rather short series of admissions; especially when it comes to a disease like erysipelas, which can be very capricious in its course and can sometimes be cured spontaneously in a couple of days, which has given rise to the superstition that Rosen was cured by magic spells.

Dr. K. has had occasion to use the treatment on 13 persons. By counting the relapses as independent, he gets a total of 18 cases. The 15 were of the usual type of facial erysipelas, the 3 had their seat partly on the body and partly on the lower extremities. All the patients came into the red room shortly after the onset of the disease, and with the exception of the first 3, who got some alcoholic compresses, no other treatment was applied either internally or externally. Dr. K. does not seem to have treated other erysipelas patients in the usual way during the same period. However, it would have been a somewhat safer starting point for the assessment of the new treatment than Dr. K. to refer to the fact that the average duration of the facial erysipelas is set at at least 1 week; for the erysipelas in Liegnitz could have been particularly benign at the time the experiments were made.

The observations that Dr. K. has made during the treatment of these 18 cases in the red room are now the following:

The fever usually lasted only 2 days. Most often it stopped the day after or at the latest the 2nd day after the patient was placed in the red room. Only in 2 cases was it different, but in one it was due to pneumonia, in the other to what seemed to be a completely inadequate exclusion of the harmful rays.

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This had been done with a care that cannot be overstated. A sickroom in the rose. epidemic ward had been completely transformed into an excellent photographic darkroom: window panes of ruby glass, walls and floor painted red, lamps like those photographers use with red glass and hoods; even the surrounding rooms: the corridor, the anteroom, the toilet and the bathroom had red windows. In this "really red room" the 14 cases were treated. Of the remaining 4, 3 were in absolute darkness and also gave good results, while 1, and that was the one referred to above, was in quite unfavorable conditions, namely in an ordinary room with 4 windows, which were indeed covered, but which, according to what Dr. K. later heard, had probably been opened during the morning cleaning. In this particular case the fever persisted for 6 days with a temperature of around 39 and 40, the disease propagated, and the general condition was bad.

In discussing the device, Dr. K. touches on how often one finds a complete misunderstanding of the whole matter. There are those who believe that it is a question of treatment with red light, that one should simply let some red rays of light fall on the patient's sick places, just as one can give a steam shower. Dr. K. thus found a place where he had recommended a red room, the following: Pt. lay in his bed in a sea of sunlight, while next to him stood a lighted lamp with red glass! And that was at a doctor's.

But with regard to the exanthema, Dr. K. says that the initially sharp boundaries disappeared within 12 hours, and the progression was gradual. However, a slight redness and swelling often persisted for several days. There was no bulla formation and squamous peeling of the epidermis, as is often the case. The process usually ended with a fine scale.

There were a total of 5 relapses, but none of the relapses occurred while Pt. was in the red room. It was only after Pt. had come out into the ordinary daylight that they occurred. Twice even the same evening that Pt. came out.

Of the complications, only pneumonia was noted in 1 pt. and severe headache and fatigue in the pt. who was inadequately treated.

One would wish that the author had stated how Ptt. was in the red room. However, the matter is still so — new that any information in this regard is valuable.

At the end of his article, the author seeks to substantiate the treatment with a theoretical explanation. Could it be that Streptococcus erysipelas thrives better in light than in darkness? No, this contradicts the numerous experiences about the bactericidal effect of light and some experiments that the author himself conducted. (Here at the Light Institute we have also done some experiments with streptococci. They did not show any particular tenacity towards light). Rather, as Finsen has already said a long time ago, it must be assumed that it is the skin-irritating ability of light that is the cause here. And just as Finsen has stated about smallpox, Dr. K. also believes that a large part of the medicines used so far for rose (such as ichthyol, iodine tincture, etc.) probably only work by keeping the light out. The author also draws attention to some experiments about the — pathology of Negroes, which are very interesting. According to DAEUBLER and PLEHN, Erysipelas and Phlegmone are very rare among the Negroes, and that this is something peculiar to the Negroes and is not due to special climatic conditions seems to emerge from a report from the Hospital in Dar-es-Salaam (in German East Africa), where both Europeans and Negroes are found. Erysipelas is never seen in the latter, quite often in the former. It is possible that it is the pigment of the Negroes that protects them against the disease in question.

The brief case histories that accompany the thesis are reproduced here in extenso.

1. F. W. 24-year-old nurse. The previous year, twice, the facial rosacea lasted 6 and 5 days respectively. Got

1/400. The rose on the nose, half of the left cheek and part of the forehead. Evening temp. 39.6 .

Red Room.

$^{2}/_{4}$ Morning: 38.5. No Propagation. Evening: fever-free. Redness fading.

2. A. S. 15 years old. Some swelling in the face. Had been in pain for 4 days and had been hospitalized.

21/4. Erysipelas. over almost the entire face. 38.3.

Epithem, alcohol. Red Room.

$^{22}/_{4}$ $\frac{37.9^{*)}}{38.3}$ Erys. has reached the hairy part.

23/4 $\frac{36.8}{36.6}$ Well-committed

3. B. J. 19 years old. Has had redness, swelling and bruising of the right leg for 3 days without any apparent cause. Admitted

31/4. Characteristic Erys. of the right leg with irregular borders; peripherally reaching almost to the foot, centrally to the knee. 38.0.

Ep. alcohol.

$^{1}/_{5}$ $\frac{37.6}{39.3}$ Erysipelas has spread to the foot.

Red Room.

2/5 $\frac{38,}{38.5}$ No Propagation.

3/5 $\frac{37.8}{37.5}$ 4/5 Temp. below 37. The tumor is losing weight.

4. K. P. 25 years old. Admitted 20/4 for sycosis.

2/5 400. An erysipelas develops on the left cheek.

Red Room.

3/5-6/5. Morning temp. approx. 39, Evening temp. approx. 40. Erys. extends over the entire face. Delete General condition.

7/5-8/5 The fever goes down a little.

9/5 Fever rises. Right-sided pneumonia, bloody sputum etc. The swelling on the face is decreasing.

12/5 Fever-free. Well except for some stitches in the side.

5. A. M. 54 years old. Insane. Unwell for 3 days: Fever, swollen nose. Hospitalized

18/5 390. Erys. of the nose and v. K. to the ear.

Red Room.

19/5 $\frac{37.4}{38.6}$. 20/5-21/5 below 37°. The swelling is decreasing.

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*) Temp. above the line morning, below the line evening temp. for the day in question.

22/5 Morning: Sunlight. Evening: 39°. Relapse.

Red Room.

23/5 $\frac{37.1}{36.7}$

25/5 Daylight.

6. P. S. 55 years old. For several months treated for glandular tuberculosis on the right side of the neck and in the axilla. 12/6 Evening temperature 38.5. Unwell.

13/6. An erysipelas appears, arising from a fistula and extending over the entire right side of the neck and part of the cheek. Evening temperature 396.

Red Room.

14/6 $\frac{38.8}{39}$ Erys. extends across the right side of the face.

15/6. Cessation of the Fever. Daylight. Still feeling bad. The tumor Does not stop completely until 17/6.

7. O. W. 15 years old. Supposedly had erysipelas a year ago with 8 days of fever. Has had erysipelas over almost the entire left side of his face for 2 days when he was admitted.

15/10. 38.6.

Red Room.

16 10 38.2 $\frac{38.0\ 37}{\text{Erys.}}$ Øret. 17/10 37.9 to

The following days below 37. The tumor is losing weight. 20/10 Sunlight.

Hand-26/10 Fever towards evening: Recurrence on left cheek.

39.1. Large area of redness.

Red Room.

27/10-28/10. Intermittent Fever.

9/10. Cessation of the fever. But a slight swelling remains over the entire face for a few days.

8. M. T. 25 years old. Has had redness and swelling emanating from the nose and swelling of the face for 8 days. Admitted

5/11. Erysipelas of the entire right side of the face.

Red Room.

/11 $\frac{370}{37.7}$ The tumor is decreasing. 7/11 The fever has stopped.

9. P. W. 31 years old. Laid in the Eye Department for corneal ulcer. On the night between 29/11 and 30/11, facial swelling.

1/19. Hospitalized for the rose, which occupies almost the entire face. 39.90.

Red Room.

2/19. Evening temp. 39.3. Erys. to the ear.

3/18 $\frac{39}{37.9}$ Minor Headache. Redness fades. 4/12 Fever-free. Minor Tumor. 8/12 Sunlight.

10. O. W. 15 years (No. 7). 26/11 Paany Erysipelas. Admitted 27/11, Erys. already extends over nose, cheeks, lips, eyes and part of forehead. 390.

Red Room.

20/11 $\frac{37.2}{38.9}$ No Propagation. 29/11 fever-free. The swelling everywhere much reduced. 1/19 Sunlight. Until 6/19 still a slight swelling of the left cheek

11. Th. K., 52 years old. Nurse in the Deaf-Mute Asylum. Got the facial rosacea on 6/10. Characteristic redness and swelling of the nose and Cheek. $\frac{39}{40}$

7/10. Red Room by excluding sunlight as best it could in a room with 4 windows.

Slow Propagation. Temp. unchanged high.

8/10-10/10 Same condition. Clear General condition. Erys. extends into the hairy part.

11/10 Temp. drops. 12/10 fever-free.

12. A. M., 37 years old. In the idiot asylum. 30/10 Erysipelatous redness and swelling on the right side of the face, arising from a nasal excoriation. 37.5°.

Dark room; the staff uses a red lamp when they enter there.

31/10 Below 37°. The redness is fading.

2/11. Still no fever. Redness gone. Right side of face starting to go bald.

13. J.W., 19 years. At the Institute for Idiots. In October. treated for Ozoena.

14/11. Erys. of nose, cheeks and left half of upper lip. 37.80. Dark room (as No. 12).

The temperature stays below 37. The redness does not spread any further and disappears over the next 3 days.

3/18. Fresh erysipelas on the left side of the face and over the left eyelid. Dark room.

4/12 fever-free; but Erys. has spread over a larger part of the body.

6/12. Still no fever. The redness has disappeared.

8/12. Sunlight.

14. H. M., 51 years old. Operated on 19/4 1900 for a recurrence of cancer of the penis. Above the pubis there is another fistula which secretes a little.

2/2 1901. Redness and swelling of the right cheek and lower eyelid suggest erysipelas. 3/9. No fever, but the swelling has spread over the cheek.

Red Room.

Here complete freedom from fever. The swelling immediately subsides and has completely disappeared on 6/9. The patient is sent back to his ward on 8/9. The same evening: 38.5°. A plate-sized erysipelas. originating from the fistula and already out on the left thigh.

Red Room.

Immediate cessation of fever, erysipelas. disappears and its borders contract.

Excerpt from the records of the cases of rose treated in the garrison hospital by the corps physician, Dr. Kier, in a red light:

No. 1. STEENBERG'S WIFE. In hospital from 18/11-28/11 1893 for Erysipelas faciei and Nephritis acuta. Illness. began. 2 days before admission. with chills, severe headache and swelling of the nose. On admission 18/11 Temp. 40.9. Erysipelas on the entire left cheek and eyelid, nose and part of the right cheek. Several bullae.

D. f.
Epith. boric.
Acetanilide
Centigr. 25.

$^{19}/_{11}$ $\frac{40.3}{40.2}$. Erys. now as widespread on the right as on the left. No appetite. Poor sleep due to headache.

Wine, Milk, Ice cream (outside).
Syrup. chloreti morfici. 1 Theskef.

20/11 $\frac{39.4}{40.4}$. Erysipelas has spread further up into the hairy part of the body. Part and above the ear. Pulse 108, small.

Red Room.

$^{21}/_{11}$ $\frac{40.4}{40}$. Good Sleep Without Narcotics. Finding something better. The swelling and redness of the cheeks have diminished somewhat, but the affection has spread over the forehead and into the hairline. Pulse 120, quite strong. App. extremely poor, drinks only wine and milk.

$^{22}/_{11}$ $\frac{39.2}{37.6}$. Pulse 93, strong, has been feeling less well yesterday, but is feeling well this morning. The rosacea has not spread since yesterday, and the swelling and redness in the face have diminished considerably, so that the face today is almost completely natural.

Sept. Ice creams.

She is starting to feel like eating.

Sep. D. f.
Rs. M.k.

$^{23}/_{11}$ $\frac{37.5}{37}$. Pt. is doing well overall. She has been sleeping good at night. No headache. No sm. The rose has not spread sig. The redness and infiltration have subsided well everywhere, also in the hairy part. There are remains of bullae formation all over the face. App. good.

24/11 37 / 36.8 Still subjectively well. Another little tenderness f. Pressure in the left temporal region.

Sep.
Red Room.

In the following days, albuminuria was found, which is why the patient was transferred to another service. There was no recurrence.

No. 2. ANDERSEN*), 23 years old. Admitted 28/11 for erysipelas in connection with a vulnus contus. capitis. Temp. 40.5. Clear erysipelatous redness and swelling of the left cheek and across the left side of the forehead and over the hairy part of the head on the left side.

Rp. D. f. and red Room.

29/11 40.4 / 40.7 Only slept a little last night. I'm pretty exhausted. P. 108, regular and strong. The rosacea has spread over the entire forehead and down the right cheek. Urine normal.

Rp. 1 Siphon.

30/11 40.5. / 38.7 Subjective Well-Being. Slept well last night without Narcotica. Drinks his milk and wants more. No headache, does not feel particularly tired. The rosacea has spread over the whole face. There is edema of the eyelids. Abundant bullae on the nose. Pulse strong.

Rp. 4 Milk. Sep. 1 Siphon.

1/12 39.6 / 37.5 The rose has spread behind the right ear and around the nape of the neck. region. There is quite considerable redness and swelling throughout the face, especially on the right side. Subjectively indicates well-being. Pulse 60. Urine normal. A large bulla on the nose is completely dried up.

2/12 39, / 39.5 Subjectively indicates Well-being. The rose has spread into the left parotid region and to the left ear. On the right side the process has subsided well. Urine normal.

3/12 40.8 / 38.9 He's feeling pretty good, he's slept well after

Syrup. chloral morphine.
1 Teacup.

The rose is strongly pronounced on the left side of the head, especially the left ear. Want to eat more.

Rs.
Mk.

4/12 38.5 / 36.5 Well done. Good night's sleep after

Morphine juice, 1 teaspoon.

The erythema has disappeared everywhere except in the left ear, where there is still some tenderness and swelling. Urine normal.

5/12 37, / 36.5 Still insignificant tenderness and swelling of the left ear. Appetite and sleep good. Urine normal.

6/12 36.9 / 36.5 Another small lump in the left ear.

7/12 36.7 / 36.5 Swelling and redness now completely gone. feeling good. App. good. Peeling on cheeks and ears.

Sept. Mk.
Rs. Fk.

8/19. Peeling all over the face and head.

Sept. Red Room.

The following days natural conditions. Discharged 12/12-

No. 3. KNUDSEN, 20 years old. Admitted 19/12. The illness began about 2 days previously. 37.5. The nose is somewhat red, swollen and sore; the same applies to the nearest part of the cheeks.

Rs. D. f.
Red Room.

20/12 37.1 / 37 Well done. The rose has not spread. Urine normal.

Sep. D. f.
Rs. Mk.

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*) Where nothing else is stated, Ptt. is Men (Private).

21/12 $\frac{37.1}{\text{and}}$ Complete well-being. Swelling and redness of 36.6 nose adjacent part of cheeks have completely disappeared. Peeling of these parts.

$^{22}/_{12}$ $\frac{37}{36.6}$ Well done. The nose is natural.

Rs. Fk.
e. l.

23/12. Well done. Nose natural.

To be printed.

No. 4. KIRKEGAARD'S WIFE, 32 years old. Admitted 14/12. 2 days before admission. Chills and fever, and redness of the nose. Tp. 41. Nose and cheeks Seat of considerable erysipelatous redness and swelling. Aff. extends to the ears on both sides and up to the eyes. There is no edema of the palpebral. Clear violent borders. Bullous formation on the right side of the nose and right cheek.

Rp. Ice. D. f. Milk.
Red Room.

15/12 $\frac{39}{40\ 1}$. Pt. has slept a bit last night after Narcoticum. single vomiting. The redness and swelling have spread to the forehead. Considerable edema of all 4 eyelids. Extensive bullae formation around the nose and on the chin. Pulse quite strong, regular. Urine contained traces of albumin.

16/12 $\frac{40}{39.9}$. Little, interrupted sleep at night. Condition essentially unchanged. The erysipelas has spread somewhat up the hairy part of the head; but swelling and redness of the face as well as the edema of the eyelids have considerably diminished. Some egg white in the urine.

$^{17}/_{12}$ $\frac{39.5}{39}$. I slept fairly well last night after taking morphine. The rosacea has spread to the neck and over the ears. On the other hand, it has diminished considerably on the face and all the bullae have dried up. I feel better overall. I am eager to eat.

Rs. Mk.

$^{18}/_{12}$ $\frac{38.4}{37.}$. Slept well last night without narcotics. Good condition today The erysipelas has not spread. Still swelling and redness of both ears and the nearest adjacent part of the neck. No particular tenderness in the hairy part of the head. Face very flaky. Good appetite. There are traces of egg white in the urine.

Sep. Ice Cream, Milk and Wine.

$^{19}/_{12}$ $\frac{19\ 36.9}{37}$. Good night's sleep. All the best. Rosen almost gone everywhere, only a little soreness in the neck.

12/20 $\frac{37}{36.8}$ The rose now faded everywhere.

Sep.
Red Room.

The albuminuria persisted until discharge on 23/12.

No. 5. STEENBERG. Admitted 18/12. Illness began 11/2 days ago with strong chills. Currently very ill, drowsy and pale. Temp. 40. Considerable erysipelatous redness of nose and adjacent parts of cheeks.

Rs. D. f.
Red Room.

19/12 $\frac{40.3}{40.3}$. The redness and swelling have spread greatly. over the cheeks and up to the forehead. There is edema of all eyelids. Bullae formation on the cheeks. Has slept last night without sleeping pills and still dozes a lot. Pulse regular, but a little slow.

$^{20}/_{12}$ $\frac{8\ 39.8}{40}$. Sleep has been bad last night. The rose has spread extends over the forehead and all the way to the ears. On the other hand, it has faded a little on the cheeks. The general condition is generally bad.

21/18 $\frac{40.9}{40.1}$. Pulse 108, regular, strong. He states that he feeling better. Slept a little last night after taking morphine. The rosacea has spread up the hairy part of the head to a line corresponding to the coronal suture. Quite a lot of swelling and tenderness of the forehead. The affection has disappeared on the cheeks and nose. Bullae are

parched. Peeling on the face. Quite thirsty. No appetite.
Urine normal.

$^{22}/_{12}$ $\frac{40.4}{39.7}$. Pulse 96, regular. Slept well last night after Morphine-juice. Feeling better overall. The rosacea has spread to the Isse and Tindinge regions, but has diminished considerably on the face.

$^{23}/_{12}$ $\frac{40.1}{39}$. Bef. seems to be a little better. Today Tumor and Soreness of the entire neck region and right ear. In the face, Rosen has lost a lot of weight.

$^{24}/_{12}$ $\frac{40.4}{38.5}$. Was cloudy during the day yesterday. Wild out-written and out of bed. Slept peacefully last night without morphine. Bef. himself in the morning quite food. The rose is almost unchanged. Beginning well. to get an appetite for

Rs. Mk.

25/12 $\frac{40}{37.5}$. Feeling better. Wasn't foggy yesterday. Slept well last night. The erysipelas has hardly spread, but there is a little swelling and tenderness on the left side of the neck and right ear. The process on the face has subsided well, there is very severe peeling.

$^{26}/_{12}$ $\frac{40.3}{40}$. Today the rose has appeared again in the left half of the face. Edema of the left eye's palpebral fissure. Some drowsiness. Pulse 86, regular, quite strong.

$^{27}/_{12}$ $\frac{39.8}{37.5}$ Have slept last night. The rose has not spread, but it begins again on the left half of the nose.

$^{28}/_{12}$ $\frac{39,1}{37.5}$ Is doing quite well. The rose is now back in Africa. tagende.

$^{29}/_{12}$ $\frac{39,6}{37.6}$. Get well soon. Still redness, swelling and tenderness of left ear. Very severe peeling on face.

$^{30}/_{12}$ $\frac{37.2}{36.6}$. Well done. Good night. Still only the rose of v. Ear. Urine normal.

$^{31}/_{12}$ $\frac{40.6}{37.8}$ Felt unwell last night. Chills. Sm. behind v. Ear. Today Bef. is better, and Sm. has lost weight. Nothing objectively abnormal. The erysipelatous process has stopped everywhere. Strong Peeling.

Sep.

Red Room.

The following days are OK. Discharged 4/1.

No. 6. HANSEN, 22 years old. Admitted 24/19. Illness. started about. 2 days ago. 37.6 and nearest part. redness of nose No bullae. No clear of left cheek. There is erysipelatous border for the Process.

Rs. D. f.

Red Room.

$^{25}/_{12}$ $\frac{38.5}{39}$. The rose has spread to the left ear. There is now clear violent boundary upwards at the Tindinge region.

$^{26}/_{12}$ $\frac{40}{39.9}$ The subjective feeling is good. I have slept. good. Appetite good. The rosacea has spread over the right half of the face and over the hairline. Urine normal.

Rs. Mk.

$^{27}/_{12}$ $\frac{39.5}{37.6}$. The rose has spread a little towards the left ear. Well done.

$^{28}/_{12}$ $\frac{38.3}{37}$. The rose today is strongly pronounced in the left ear.

$^{29}/_{12}$ $\frac{37.7}{37.5}$ Still redness and swelling of left ear. Severe tenderness. and swelling of the glands behind the left ear. Subjectively well.

Rp.
Epithem. tepid.

$^{30}/_{12}$ $\frac{37.5}{37}$. The aforementioned tenderness of Old has lost its weight. Yet Redness and swelling of the left ear.

Rs. Fk.

31/12 $\frac{36.7}{36.6}$. Completely fine. Still only a little redness.

of left earlobe.

Sep.

Red Room.

The following days still well. Discharged 6/1.

No. 7. KIRKEGAARD'S WIFE, 32 years old (refers to No. 4). Admitted 26/12. Became ill again immediately after discharge from previous hospital stay. 39.9. There is some redness and swelling of the nose and the nearest part of the cheeks. Some edema of the lower eyelids of both eyes. On the nose a few bullae.

Rp. D. f. Milk and Wine.

Red Room.

12/27 $\frac{39.7}{37.9}$

37.6 —. 28/18 37 Pretty good sleep at night. Overall better.

The rose has not spread. The urine is normal.

29/12 $\frac{37.6}{36.9}$ Well-being No Spread of the Rose. Face almost natural.

30/12 $\frac{37.6}{37}$. Well-bef. Rosen has lost some weight in her face,

Still some tenderness and swelling in front and behind the ears. Urine normal.

Sep. Milk and Wine.

Rs. Mk

31/12 $\frac{37}{37}$ Well done.

Printed 9/1.

As can be seen, it is not possible to draw any reasonable conclusions from these last 7 case histories. In the few cases (Nos. 1, 2 and 3) where a favorable effect of the treatment could be assumed, it is possible that the course would have been just as favorable without treatment. On the other hand, the cases where the fever persisted and the disease

spread despite the treatment, nor is there any conclusive evidence that the treatment is ineffective, for without this treatment the course would possibly have been even worse. The capriciousness of this disease makes it impossible to draw conclusions from it. All we can say is that Dr. Kruckenberg's case histories undoubtedly give an overly favorable picture of the effectiveness of this treatment in the rose.

However, there is every reason to continue with these experiments, which should preferably be carried out in a larger hospital and quite systematically with trials and control trials. This treatment has in any case the advantage over so many others that it is harmless, so that one need not have the slightest misgivings about conducting experiments with it.

LITERATURE REVIEW.

PAUL DARBOIS: TRAITEMENT DU LUPUS VULGAIRE SUIVANT LES INDICATIONS. Paris 1900.

The author reviews the technique and results of a number of different methods of treatment for Lupus vulgaris, about 30 in total. Of these, he believes that the following are capable of curing the disease: Scarification, Ignipuncture, galvanocaustic Scarification (scarification ignée), the surgical methods (excision, scraping), Caustica, Finsen's Method.

Of the newer treatment methods, the author believes that the following are not capable of curing the disease: Koch's Tuberculin TR, Streptococtoxin, various sera, Holländer's Hot Air Method, Calomel Injection, d'Arsonval's Currents (high frequency and high intensity currents), Electrolysis, X-rays.

It is interesting that d'Arsonval's currents, which have given good results against lupus erythematosus, have no improving effect whatsoever on lupus vulgaris.

An ideal treatment, says the author, must be easy to use and painless, and must quickly provide definitive healing and beautiful scars. Regarding these individual points, he notes that, 1) none of the other methods produce scars as beautiful as those obtained by scarification and the FINSENS method. 2) Definitive healing can be achieved by all of the methods mentioned, provided that the patients can be kept under observation for at least 2 years to treat any relapses and remaining lupus foci. The author therefore does not consider it a

objection to the FINSENS method, that patients must as a rule undergo one or more short-term follow-up treatments in the first couple of years after the completion of the main treatment. 3) The quickest treatment is undoubtedly excision, provided that suppuration is avoided. This method is therefore recommended by the author in cases where the disease is operable and is located in a place where the appearance of the scar is of secondary importance. In second place, as far as speed is concerned, is the FINSENS method. With all other methods, including scarification, it takes longer to achieve healing than with the FINSENS method.

4) The author rightly considers the painfulness of the treatment to be one of the most important points. None of the other methods can stand in this respect alongside FINSENS, which causes no or almost no pain.

From the above it will be seen that the author considers the FINSENS method to be the most perfect. In his "Conclusions" he has expressed this view in the following way: "The FINSENS method is indicated in the majority of cases. However, lupus on the mucous membranes cannot be treated with this method. Furthermore, it cannot be used with people in the country and poor people who cannot get to the hospital."

"With these reservations, it can be said that, due to the relative rapidity of the effect and the excellent scars it produces, the FINSENS method is the best of all the treatments used in lupus therapy."

This recognition of the superiority of FINSENS's method is given increased significance by the author explicitly noting in his introduction that "it is Dr. Brocq who first had the idea for this work, and it is he who has partly inspired the conclusions."

VALDEMAR BIE.

LEREDDE: LA PHOTOTHÉRAPIE ET SES APPLICATIONS A LA THÉRAPEUTIQUE DES AFFECTIONS CUTANÉES. Bulletin général de thérapeutique. 70^{e} année, t. 141 p. 129.

CLAY: LA CURE PHOTOTHÉRAPIQUE DU LUPUS ÉRYTHÉMATEUX.

Bulletin de la société de thérapeutique. 36^o année, 4^a série, t. VI, no. 1, p. 21.

The author gives a detailed account of FINSENS's "La Photothérapie", and also publishes his own experiences of treatment with concentrated light according to Finsen's method.

Regarding the results of the treatment of lupus vulgaris, the author is of the same opinion as Darbois: FINSENS' method is the least painful and gives the largest percentage of cured cases, the surest definitive cure, and the most beautiful scars. He also has only one objection: the expensiveness of the treatment will prevent poor patients who cannot come to the hospital from using it. But he assumes that the head of the public charity will understand that it is cheaper to pay for the cure of such patients than to have them sooner or later put in the poorhouse.

LEREDDE has treated a patient with acne rosacea nasi. Considerable improvement was achieved, but so slowly that if it always goes like this, LEREDDE can only recommend light therapy in the few cases of this disease that cannot be cured by the usual methods of treatment.

On the other hand, he has been very satisfied with the results of light therapy in a severe case of Rhinophyma; the lower end of the nose was twice as large as normal and transformed into a blood-filled sponge. After 30 sessions of 1/2-1 hour duration, a significant reduction of the nose was achieved, and the color became pink.

The author has also treated two cases of sycosis several years old which had resisted all treatment. In one case, after 12 sessions of treatment, a very marked improvement was achieved.

In "la Société de thérapeutique" LEREDDE has published his experiences on the treatment of lupus erythematosus with concentrated light according to the FINSENS method. He has treated 11 cases, almost all of which had previously been treated with the greatest perseverance, but without result, with almost all the known methods.

It is of particular interest to Forf that one of the patients, who had previously been treated without results, including 70 sessions with D'ARSONVAL'S currents — In his and BROCQ's opinion, one of the best treatment methods for Lupus erythematosus was — significantly improved by 22 sessions of light therapy.

In 2 of the 11 patients treated, only a slight flattening, reduction of congestion and atrophy of the epidermis at the treated sites have been achieved. The author notes that the treatment has been too short (10-12 sessions) to allow any definitive judgment to be made.

In 3 severe cases, the author has achieved partial recovery and, for the rest of the suffering, considerable improvement.

Finally, in 3 cases complete recovery has been achieved after 35, 7 and 45 sessions respectively, and 3 other patients, whose treatment has not yet been completed, have improved so much after 40, 22 and 30 sessions that LEREDDE dares to predict complete recovery. All in all, LEREDDE believes that FINSENS' method is the best method for treating the severe forms of Lupus erythematosus.

VALDEMAR BIE.

MALCOLM MORRIS AND S. ERNEST DORE: REMARKS ON FINSENS LIGHT TREATMENT OF LUPUS AND RODENT ULCER.

British Medical Journal Nr. 2093, 9. Febr. 1901, p. 326.

This article contains, among other things, some valuable remarks regarding the technique of treatment, the skin reaction, favorable and unfavorable conditions for the treatment, etc.

In all the cases of lupus vulgaris that the author has treated, there has been a clear and regular improvement, although in some cases very slowly.

There has also been a clear effect on lupus erythematosus, although not as certain as on lupus vulgaris. A medical history is given which definitely indicates that in the treatment of this disease it is important to produce as severe a skin inflammation as possible.

Most interesting are Forff.'s observations on Ulcus rodens. They believe that the light has a distinct stimulating effect on the tissue at the base and edge of ulcerations, both in lupus vulgaris and in Ulcus rodens, so that soon after the treatment a rapid ingrowth of epithelium from the surroundings begins. In some cases, where the epithelium was not ulcerated, the tumor after the treatment became red, slightly excoriated and softer, and disappeared little by little without loss of substance.

VALDEMAR BIE.

STEPHEN MACKENZIE: ON PHOTOTHERAPY, OR THE LIGHT FREATMENT OF LUPUS VULGARIS. The British Journal of Dermatology Vol. 11, Nr. 133.

LORTET ET GENOUD (FACULTÉ DE MEDICINE DE LYON. LA-BORATOIRE DE PARASITOLOGY): LA LUMIÈRE AGENT DE THERAPEU-TIQUE. Lyon 1900.

THEODER SCHÜLER: UEBER LICHTBEHANDLUNG MIT SPECIALIZES BERÜCKSICHTIGUNG DER PROFESSOR FINSEN'CHEN BEHANDLNUG MIT KONCENTRIRTEN CHEMISCHEN LICHTSTRAHLEN. Monatsschrift für orthopädische Chirurgie und physikalische Heilmethoden. Vol. I, No. 3, 1901.

HENRY W. STELWAGON: PHOTOTHERAPY IN CUTANEOUS MEDICINE. The University Medical Magazine, Dec. 1900.

These four treatises contain accounts of the author's visit to Finsen's Lighting Institute.

VALDEMAR BIE.

MAGNUS MØLLER (Stockholm): Der Einfluss des Lichts auf die Haut in gesundem und kranhhaftem Zustande.

Bibliotheca medica. Abt. D. II, Dermatology und Syphili-dologie, herausg. v. Prof. GENESIS. 142 pages. E. Stuttgart 1900. NÄGELE.

In this book, which is furnished with beautiful photographs and histological plates, the author gives a comprehensive presentation of recent years' research into the effects of light and X-rays on the skin. The effect of sunlight and electric light on healthy skin is treated with great care, and the significance of light for "summer prurigo", Hydroa æstivalis, Xeroderma pigmentosum and related disorders, as well as the effect of light on pellagra and the FINSEN treatment of smallpox.

The author also reports some lighting experiments he himself has carried out, with accompanying histological investigations of great interest. He has used the same lighting apparatus with which WIDMARK in his time carried out the fundamental experiments on the skin-irritating ability of ultraviolet rays, namely a water-filled metal cylinder, one end of which was closed with a lens of rock crystal with a focal length of 13 cm., the other with a flat glass plate with a cutout in which a flat rock crystal plate was inserted. The rays from an electric arc lamp of 1200-4000 normal lights were made parallel by the rock crystal lens mentioned and then passed the water layer and the glass and rock crystal plate, behind which the author illuminated his own skin or the skin of experimental animals. His experiments led to quite similar results as WIDMARK'S and FINSENS'S. When using a suitable light intensity and a suitable exposure time, only the areas of the skin that corresponded to the rock crystal plate showed erythema, while those of the rays that had passed through glass showed no such effect, from which the author concludes that the effect must be due to the ultraviolet rays, although, as he himself points out, one does not dare to conclude that the visible rays cannot have a similar effect on the skin even at higher light intensities. As an effect of the ultraviolet rays, the author observed, in addition to the well-known vasodilation, a decreased transparency in the epidermis as a result of proliferative processes. This "clouding" of the epidermis appeared 2-3 days after the exposure; it increases in the same proportion as the photochemical redness decreases, and it persists until the peeling stops. It appeared particularly clearly when the treated skin area, e.g. on a rabbit ear, viewed in transmitted light. Histologically, the lesion is due to reduced transparency "a parenchymatous edema, an abnormally increased sap content in the epithelia with accompanying hyperplasia", which is particularly evident in the case of the stratum corneum, which becomes more than twice as thick as normal and shows an abnormal process of cornification, as the nuclei of the corneum cells are well preserved and are affected in an abnormal way by dyes. This process, caused by the ultra-violet rays, serves, in the author's opinion, to protect the deeper layers in a similar way to the cardilation and the later occurring pigmentation.

The author investigated the deeper effects of light particularly on the ears of white rabbits, by using WIDMARK's apparatus to concentrate the light on the inside of the ear. With a suitable light intensity he not only obtained an inflammation limited to the rock crystal part with bulla formation on the inside of the ear, but also a corresponding, albeit less severe, affection on the outside of the ear. The author regards this as proof of the "not insignificant deep effect of the ultraviolet rays". In view of what we otherwise know about the poor ability of the ultraviolet rays to penetrate deeply, it is perhaps doubtful whether the author is right in this view; it is perhaps more a question of a collateral flux of considerable intensity. The histological examination of the vascular dilations showed, — among other things, a very strong dilation of the smaller arteries; While their lumens generally appear on section to be surrounded by a thick, more or less contracted muscularis with a strongly folded elastica, the light-exposed arteries, on the other hand, showed a thin, distended muscularis and an almost smooth elastica, so that they more resembled veins than arteries. At the strongest illumination used, thrombus formation occurred in the skin vessels.

A series of experiments on guinea pigs and rabbits with the intention of investigating whether "solar stasis" can be induced by exposing the heads of these animals to strong ultraviolet light led to negative results, nervous phenomena only occurring in cases in which the heat rays were not sufficiently carefully excluded.

SOPHUS BANG.

SØREN HANSEN: On the Sunlight in Copenhagen. Some Remarks on the Occasion of the Revision of the Building Act.

Journal of Health Care. 1 R. VII. P. 65-78.

The author would like to draw attention to the fact that the Building Act should take into account the lighting conditions of streets and homes to a much greater extent than has been the case so far. The focus of the Building Act has certainly gradually undergone a very commendable shift, as the regulations, which were dictated solely with fire risk in mind, now increasingly focus on hygienic conditions. But a sufficiently open view of the hygienic significance of light seems to be lacking so far. Copenhagen is already treated rather stepmotherly by nature when it comes to sunshine. Of the 4400 theoretically possible hours of sunshine per year, the sun only shows itself for 1200, while, for example, Berlin has 1727. Of the larger cities, only London (with 1026 hours) seems to lag behind us. Added to this is the poor quality of a large part of the sunshine that we are given. One would think that in these circumstances there was an invitation to erect the buildings in such a way that they take as little sun from each other as possible; but the author's calculations show that our building law, far from being perfect in these respects, on the contrary places us more unlucky in terms of sunlight on the facades than the cities with which we could be most closely compared, e.g. Berlin. In our country, the height of the house is not allowed to reach 5/4, and under certain circumstances even more, of the street width; in Berlin the height of the house may not exceed the street width. This means that in a street running east and west, with houses 27 cubits high, the northern row of houses in Berlin will at noon on the equinox have a vertically 6 cubits larger sunlit area than the corresponding row of houses in Copenhagen. In order to achieve the Berlin lighting conditions, the southern row of houses in Copenhagen would only have to be / of the width of the street instead of the prescribed 5/4. For the inner city, such requirements cannot of course be implemented; on the other hand, it would be possible for the suburban districts, for which the author even suggests the normal ratio of 2/3, which would mean that the southern row of houses at noon on the equinox could not shade any part of the northern row of houses. It is to be hoped that what they now

The ever-increasing demand for brighter light as a comfort and the growing understanding of the hygienic importance of light in combination could cause the author's very appreciable proposal to be taken under closer consideration by the authorities.

SOPHUS BANG.

HUGH WALSHAM: On the ultra-violet light from a rapid oscillation high-tension arc, for the treatment of skin diseases. — The lancet. — Feb. 1902.

Ultraviolet rays with a wavelength of about 200 μμ make the air through which they fall conductive to electricity. The author has used this — property to investigate the penetrating power of these rays. As a light source he uses an alternating current — lamp, which is not described in more detail. When the rays from this lamp are directed towards an electroscope charged with negative electricity, its gold leaves will collapse, and the author uses the speed with which this occurs as a measure of the amount of the rays in question. By inserting various bodies between the lamp and the electroscope, he determines their absorption ratio. According to the experiments, 2-2 mm thick quartz plates at a distance of 10 mm from each other will absorb 60% of the rays that affect the — electroscope. If the space between the plates is filled with water (distilled? boiled?) 10-15% of the remaining rays are retained. A gelatin plate of 0.04 thickness stopped all the rays while a 6 inch thick block of ice hardly absorbed more than the corresponding air column.

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This circumstance led the author to use small, inch-thick pieces of ice as compressors in the case of Lupus's lysophia instead of the Finsen pressure glasses. The author assumes that the cold effect of the ice will also contribute to complete the local ischemia. —

The fact that the author has been able to use this technique at all is explained by the fact that he uses a weak light source without concentration of the rays for the treatment of lupus, and that the sessions do not last longer than 10-15 minutes. Experiments at Finsen's Light Institute have shown the inadequacy of both parts, and in addition, rays — with such great fragility is absorbed into the very top layer of the skin. — The author admits this, emphasizing that the penetrating power of light rays decreases with their wavelength, but he tries to get around the matter by saying that "the wavelength is so easily lengthened or shortened when the rays strike different bodies that it would not be wise to dogmatize on this point."!

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It goes without saying that such use of ice as a compression agent must also be very troublesome for the patient; the author does not even mention this side of the matter.

GUNNI BUSCK.

G. J. MÜLLER: Actinotherapy. — calendar und Recipe Taschenbuch. 1902. Berlin. Medicinal

Under the name "Aktinotherapy", the author summarizes below 4 modern, physical healing methods, of which he gives a clear and concise presentation.

Use of: 1) the concentrated chemical rays from arc lamps or sunlight according to Prof. Finsen's method.
2) X-rays.
3) Ultraviolet rays of the induction spark according to Strebel's method.
4) Becquerel rays.

In his discussion of concentrated chemical rays, the author essentially agrees with the views expressed by Finsen and his students; only, purely theoretically, does — he place greater emphasis on the rays' inflammatory properties than on their bactericidal properties.

The author recommends X-rays especially for Beh, for Hyper-trichosis, Sykosis parasitica and Favus. He finds them contraindicated in all acute, inflammatory dermatoses. —

Strebel's apparatus for utilizing the ultraviolet rays of the induction spark and the Becquerel rays (chemically acting rays emitted from uranium and thorium) is only briefly mentioned by the author. —

GUNNI BUSCK.

Dr. ENGEL (Cairo): Zur Behandlung der Pochen mit rothem Licht nebst einigen Bemerkungen über forcirte Vaccination.

"Therapie der Gegenwart", March 1901.

During an epidemic that occurred in Egypt in the spring of 1900, a total of 177 cases of smallpox were admitted to the Infectious Disease Hospital in Cairo. Of these, 25 were treated according to Finsen's method.

As a result of a well-conducted mass vaccination (in April alone, over 278,000 of Cairo's inhabitants were vaccinated or revaccinated), the epidemic stopped shortly after this measure was put into effect.

The author publishes his results in the above-mentioned thesis, expressing the hope of thereby contributing to spreading knowledge of a method that has not yet gained the attention and dissemination that, in the author's opinion, it deserves.

The author describes the enormous change that occurred in the sickrooms after the exclusion of the chemical rays: the penetrating stench, which the accumulation of many suppurating wounds had made almost unbearable, disappeared completely, and with it the numerous flies that had previously been a constant nuisance for the wounds.

The author has not been able to observe any harmful effect of the stay in the filtered light on the patient or the staff, but he emphasizes that the patient becomes impatient and can only be kept in with difficulty until the vesicles have completely dried up because subjective well-being occurs so early. —

While the skin efflorescence still assumed an abortive, benign character, without suppuration, the author found that Beh. had no influence on the exanthem localized to the mucous membranes (pharynx, larynx, conjunctiva), and he believes that he finds in this the reason for the contradictory results of the various observers with regard to the condition of suppurative fever under Finsen-Beh. It appears from the reported case histories that the affection of the mucous membranes is on the whole of great prognostic significance, something to which previous authors (e.g. Ex. Curschmann) have also drawn attention.

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When writing the — author disregards the four cases of Purpura variolosa and Variola hæmorrhagica, as well as the cases,

Where the mucous membranes are primarily severely affected, the disease will progress like variolois, and the cosmetic result will be satisfactory at that time. Treatment according to Finsen's method.

The author calls this: the first rational and methodical treatment of Variola; he believes that it should be introduced everywhere as an obligatory part of smallpox treatment, and that permanent installations for such treatment should be established in all cities where smallpox occurs constantly or — even regularly.

As can be seen, the author unconditionally and enthusiastically joins the supporters of the method. His view of the influence of the treatment on mortality is all the more strange. The author does not believe that it will lead to any significant decrease in the mortality rate, although he admits that it can have a certain influence on it by preventing mixed infection and complications in the later stages of the disease, something that will be of particular importance for old and weak patients.

One should certainly be careful with numbers, but one can also be so cautious that one's conclusions are misleading. By reviewing the — author's statistics, it also turns out that he has been very cautious!

Koppepttt., of whom the fewest were vaccinated, and none were revaccinated, were interned in 2 pavilions A and B. - The milder cases were admitted to A, the more severe to B, and this distinction between mild and severe cases continued in the same way after the Finsen-Beh. on May 8th was introduced in Pav. B. The mortality rate was before May 8th in Pav. A: — 17 (6 of 35) - in Pav. B: 45 (9 of 20). After May 8th, 20% (1 of 5) died in Pav. A. Of these 5 Ptt., who died in Pav. B also 20% (5 of 25). despite Beh. in red light, one — brought in in the suppuration stage, — was a child who was first and thus came under Beh. too late, since the significance of the method is precisely that it prevents suppuration. The + others had what Forf. just highlights, alongside a confluent skin exanthema, an intensive and severe affection of the mucous membranes of the pharynx and the respiratory tract. —

It is from these figures that the author draws his conclusions!

Note: Various research monographs on Variola have sought to find statistical data on which days of illness the deaths occur most frequently. It is a given that Finsen-Beh., which only aims at preventing suppuration, cannot influence the mortality in the first 9 days of illness. On the other hand, it is equally clear that the mortality due to cutaneous suppuration and the complications dependent on it will be reduced to zero the moment suppuration is prevented.

It is stated by most authors that Purpura variolosa almost always results in death during the first week of illness. If we disregard these exceptional cases, on the — other hand, the greatest mortality occurs during and after the period of suppuration.

the author now considers it clinically established that by excluding Since the inflammatory rays of light from the pox, one spares these from cutaneous suppuration and its consequences, he must logically also conclude that such a treatment must reduce the mortality rate for variola.

The author finally mentions forced vaccination. He believes that it can have a favorable influence on the secondary period, that it hardly involves any danger to the patient, and that it should therefore be tried wherever one does not find it possible to carry out Finsen's method.

GUNNI BUSCK.

DEGRAIS: Des rayons chimiques et de leur emploi dans la thérapeutique des affections cutanées. (Traitement du Lupus par l'appareil Finsen).

Thesis. Paris. 1901.

The author has thoroughly studied the literature that has appeared in recent years on chemical light rays. Magnus Møller and Finsen seem to be his main sources. Without engaging in criticism, he leads the reader in a few pages through the entire physiology of light: the influence of light on metabolism, the erythema of light, pigmentation, excitation and permeability.

After the general part comes a description of phototherapy. Finsen's concentration apparatus for sun and electric light is described in detail. Furthermore, Lortet et Genoud's and Foveau de Courmelles are described.

a Trouvé's apparatus, and an acetylene lamp, indicated by Collevilles. The author speaks with great caution about these last. We still only know the value of the Finsen installation, and the results the author presents are all due to this, as it is found at the Saint Louis Hospital (Dr. Balzer's service). He has a total of 16 case histories: 13 lupus vulgaris partly cured and partly improving. In 3 of the cases Finsen treatment was combined with scarifications (Leredde's suggestion), and the author expresses himself very satisfied with this. The scarifications were carried out under cocaine anesthesia immediately before the light treatment. The remaining 3 were lupus erythematous. They proved refractory.

Finally, the advantages and disadvantages of the Finsen treatment are weighed, and the indications for it are set — all in substantial agreement. out with DAUBOIS's dissertation (which is reviewed in this booklet).

HANS JANSEN.

BAYLE: Contribution to the study of phototherapy. (Method de Finsen).

Thesis. Lyon 1901.

This dissertation was written under the auspices of Prof. Lortet and Dr. Genoud, and the result is that their lamp can replace Finsen's. The work is as a whole very thorough. It is divided into three sections. The first gives an overview of what was known about the effects of light before Finsen, and the French contributions are particularly emphasized; the second is devoted exclusively to Finsen's work, and the third deals with Lortet and Genoud's lamp.

With regard to the last section, reference can be made to the Review of Lortet and Genoud's Original Treatises, as there is nothing significantly new in Bayle.

HANS JANSEN.

FOVEAU DE COURMELLES: La Finsenthérapie. Le Médecin. August 4, 1901.

FOVEAU DE COURMELLES: La photothérapie. — Le Progres medical. November 2, 1901.

The articles mentioned are only a few of the numerous ones that the author has published in the last six months. In all of them, the author moves in the most peculiar way from lyrical outbursts of emotion to deep scientific knowledge and refers to every bit of what has been published in the field of light therapy, without making any distinction whatsoever. However, they all result in the fact that the only excellent thing is an apparatus he himself constructed, which is described and illustrated, but in such a vague way that it has not been possible for the reviewer to get any clear idea of it. The light source can be either an incandescent lamp with special carbon (lampe à incandescense à charbon special), the composition of which has not yet been published", or an ordinary arc lamp. In both cases only 5-8 amps are needed. Finally, it can also be an acetylene lamp. This light source is now placed inside a metal casing, the back of which forms a parabolic mirror, the front a screen with a quartz window in it. The casing consists of double walls everywhere, between which water flows. The light source is placed in the focus of the mirror, whereby all the light is sent forward as parallel rays. There seems to be no concentration. Only the rays that hit the window pass out to Pt. A closer criticism of such a poorly defined lamp is impossible; it should only be emphasized that the use of mirrors was tried long ago in Denmark, but was again abandoned, as they are very quickly attacked and destroyed, at least, when using an arc lamp.

HANS JANSEN.

LORTET & GENOUD: Appareil photothérapique sans condensateur. Comp. clear des séances de l'Acad des Sciences t. CXXXII p. 527 (March 4, 1901).

LORTET & GENOUD: Phototherapy apparatus without condenser for the application of the Finsen method.
Lyon Medical (March 17, 1901).

Notice sur l'appareil photothérapique de Lortet & Genoud.

Prof. LORTET, Dean of the Medical Faculty at Lyon, who was one of the first to introduce Finsen's Phototherapy in France, has not limited himself to this. In conjunction with Dr. GENOUD, he has sought to produce an improved device for the phototherapeutic use of the arc light, and it is this "lamp" which is presented to the public in these treatises. Although it is hardly as excellent as the authors seem inclined to believe, there is nevertheless a great deal of good in their efforts, and since the lamp has gained quite a wide distribution in France, it has thereby further contributed to paving the way for phototherapy.

LORTET and GENOUD have set themselves the goal 1) to avoid the concentration apparatus, since it absorbs part of the light, and 2) to arrange the lamp for individual treatment, so that every practicing physician can have it in his office. They therefore use an electric projector lamp (an ordinary arc lamp with inclined carbons), which essentially sends the light out to one side, and they place the diseased part a few centimeters from the arc. They make this possible by inserting a metal screen with double walls between the point and the light source, between which cold water flows. This has a circular opening of 2.5 centimeters just in front of the arc, which is closed with a Finsen water-soaked pressure glass. When the point is pressed firmly against this, any heating effect must be excluded. The lamp must be regulated by hand and can be adjusted in all possible ways by numerous screws. It should burn with 12-15 Amp., 55-65 Volt, the arc should be 2-4 Cent.'s distance from the pressure glass and the duration of the sessions should only be 10-15 Min. (in the earliest treatises it is stated respectively 8-10 Amp., 1-2 Cent.'s distance and 15-20 Min.).

Quite apart from the impracticality of having to place the Pt. in that way and having to regulate the lamp by hand, it does not seem reasonable at first that this lamp should be able to provide the same performance as the Finsen installation. It is certainly impossible to find out the relationship between the two devices by calculation. For on the one hand it is not easy to determine how much LORTET gains by the projector position, and on the other hand it is not possible to calculate how much the Finsen loses in the concentration apparatus. We can only point out the following: 1) LORTET does not get full benefit of the projector position. The crater will then lean somewhat up on the side of the coal, but will not be able to stand absolutely vertical, and the rays will therefore not go straight horizontally out to the side, but a large part at least will go outwards and downwards and thus partly hit the pressure glass at an unfavourable angle, partly not hit it at all. 2) The point is not at all so close to the light source. For in addition to the 2-4 cents. that lie between the arc and pressure glass, this represents a further 2 cents., so that the treatment distance becomes 4-6 cents. As the treatment distance of the lens, one must set the distance from the arc to the front lens in the concentration apparatus; here the rays are made parallel and thus retain their intensity as far as possible in the further course. This distance is 12 cents for a usual 7 cent. apparatus. LORTET therefore takes the light to a place where it is 4-9 times stronger than where Finsen takes it. But whether this small advantage in connection with the projector position could compensate for: firstly Finsen's concentration, whereby the light is amplified by about 30 times according to the calculation, furthermore his 5 times as much power consumption and finally his 4-5 times as long processing time, it is unlikely.

The question can, however, only be resolved by exact comparative experiments. Of such LORTET and GENOUD do not cite a single one. They conclude exclusively from "les effets réactionnels et curatifs". Exanthem and bulla formation occur just as with the Finsen treatment. But it is probably not known to Forff. that Finsenapp. can do quite the same in an even shorter time. The maximum reaction is reached quite quickly, often in just a couple of minutes, and an increase in the time of illumination or the intensity of light does not significantly change its appearance, whereas it must be assumed that the depth effect becomes all the greater. Finsen has therefore rightly never been satisfied with the time and intensity of light that were just necessary to obtain the maximum reaction, but has gone much further and can probably precisely for that reason achieve a greater depth effect.

It should be added that here at the Light Institute we have carried out a series of experiments with the LORTET lamp, which will be published later, and the main result of which has been that this lamp is 3-4 times more effective in terms of bactericidality and depth of effect.

weaker than a Finsen installation with a 70 Amp. arc lamp and a 7 Cent. concentration lamp, and thus represents a significant step backwards.

HANS JANSEN.

STREBEL: SOME LIGHT THERAPEUTIC QUESTION. Vienna clinic. Roundtable No. 50-51, 1900.

STREBEL: EIN BEITRAG ZUR FRAGE DES LICHTTHERAPEUTISCHEN INSTRUMENTARIUMS. Verh. der deutshen dermatol. Gesellschaft. Breslau 1901.

STREBEL: DIE BRAUCHBARKEIT DES INDUCTIONSFUNKENLICHTES IN DER THERAPIE. Vortrag. Die 73. Versammlung deutsche Naturf. und Arzte. Hamburg 1901.

Dr. STREBEL in Munich has in recent years been very enthusiastic about phototherapy, especially its physical side, and shows considerable expertise in this area, also reviewing much criticism, although it seems to the reviewer that he is somewhat too inclined to put forward hypotheses that are not entirely justified.

In the first treatise the author rightly takes a strong distance from the so widespread light boxes, whether they are equipped with arc lamps or only with incandescent lamps. They only do very little in terms of photochemistry, and harmful gases accumulate in them. Instead he suggests leaving the Pt. in the light of strong projector arc lamps with mirror reflectors. He considers it pointless to shoot colored glass plates. Since the author here at all goes to the field against the much charlatanism that is carried on with the use of different colored light, he touches on the treatment of smallpox and here shows a strange lack of understanding, saying that he cannot see why it should be red light; darkness would have to do the same.

In the second, the author deals with the important and modern question of the value of ultraviolet rays. He demonstrates their great absorbability by a series of experiments; thus he finds that a horn plate of 1 mm. cuts off the greatest part of them like glass. Possibly, however, they could in concentrated form penetrate better, and he tries this by collecting the ultraviolet rays differentiated by a prism with a quartz lens, directing the cone of light towards a piece of skin and holding a fluorescent screen behind it; while nothing was seen through a compressed rabbit ear, on the other hand, recognizable fluorescence came through freshly removed human skin. Apart from this experiment, which one could probably have wished to repeat and vary, the moral is that the external ultraviolet rays are of little value when it comes to penetrating something into the skin. In the conclusion, the author proposes to replace the lens concentration with mirrors. A new mirror metal has been developed, called Magnalia, which is supposed to be resistant to the ozone effect of the arc light. With some drawings he shows how he imagines the installation in such a case. In the same lecture, but without connection with the rest, the author presents his "Funkenlicht", which is the main subject of —

the 3rd treatise. The principle of this "STREBEL" lamp is to let strong induction sparks pass between electrodes of aluminum, cadmium or zinc. This creates a light that is very rich in ultraviolet rays, while there are only a few luminous ones. It is almost quite cold, so that it can be introduced into the body cavities, and it is here that the author will seek an area for "ultraviolet therapy", as he suggests that the mucous membranes are better permeable than the skin. Finally, he presents some therapeutic results obtained with this light, including 2 cases of gonorrhoea and 2 cases of urethritis in men.

HANS JANSEN.

At Gyldendalske Boghandels Forlag, previously came out:

ABOUT USE IN MEDICINE
OF
CONCENTRATED CHEMICAL LIGHT BEAMS
BY
NIELS R. FINSEN.
Price: 1 Kr.

Georges Carré et C. Naud, Éditeurs, Paris, has published:

LA PHOTOTHERAPY
PAIR N.
R. FINSEN.
I. LES RAYONS CHIMIQUES ET LA VARIOLE.
P. LA LUMIÈRE COMME AGENT D'EXCITABILITY. DU LUPUS — III. TREATMENT
VULGAIRE PAR LES RAYONS CHIMIQUES CONCENTRÉS.

F. C. W. Vogel's Publishing House, Leipzig, has published:

Über die Anwendung
von concentrated chemical light rays in medicine
by
Niels R. Finsen.
1899. Price: Mark 1:20.
(Translation from Danish).

Über die Meaning der
chemischen Strahlen des Lichten für Medicine
und Biology.
Drei Abhandlungen.
By
Niels R. Finsen.

1899. (Translation from French of "la Photothérapie").

CONTENT.

I. On the Use in Medicine of Concentrated Chemical Light Rays. By N. R. FINSEN, (With 8 Pictures and Figures).

II. On the Absorption of Ultraviolet Rays by Blue Liquids. By VALDEMAR BIE.

III. Studies on the Effect of Light on Smallpox Vaccines. By N. R. FINSEN and G. DREYER.

IV. On the Production of Arc Light by the Aid of Cooled Electrodes. By S. BANG.

V. On the Effects of Light on Microbes. By S. BANG. (With 6 Figures).

VI. Treatment of Smallpox by Exclusion of the Chemical Rays of Daylight. By N. R. FINSEN.

VII. Treatment of the Rose with the Exclusion of the Chemical Rays of Daylight. By N. R. FINSEN.

VIII. Literature review.